DOCUMENT RESUME

ED 316 182 IR 014 141

AUTHOR	Collins, J. H., Ed.; And Others
TITLE	Proceedings of the International Conference on Technology and Education (5th, Edinburgh, Scotland, March 1988). Volume 2.
SPONS AGENCY	Tandy Corp., Ft. Worth, TX. Radio Shack Education Div.
REPORT NO	ISBN-0-905941-27-6
PUB DATE	Mar 88
NOTE	360p.; For Volume 1, see IR 014 140; for the proceedings of the sixth conference, see IR 014 142-143.
PUB TYPE	Collected Works - Conference Proceedings (021) -- Reports - Descriptive (141) -- Reports - Research/Technical (143)
EDRS PRICE	MF01/PC15 Plus Postage.
DESCRIPTORS	*Administration; *Artificial Intelligence; *Computer Assisted Instruction; *Distance Education; *Educational Technology; Elementary Secondary Education; Higher Education; Interactive Video; Open Education; *Teacher Education; Technology Transfer; Telecommunications

ABSTRACT

The second of two volumes in these proceedings contains the text (or, in a very few cases, an abstract) of 87 papers on the use of technology at all levels of education, including elementary, secondary, and higher education. These papers were presented in 29 topic sessions and one plenary session. Themes of the sessions include: (1) educational administration; (2) enabling technologies; (3) computers to enhance instruction; (4) artificial intelligence; (5) open and distance learning; and (6) teacher education. Descriptions of 10 workshop demonstrations are also provided, as well as an alphabetical index of authors in this volume. (GL)

****

* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *

****

ED316182

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
☒ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
● Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

The Fifth
International Conference
On
Technology And Education

Volume 2

Edinburgh – March 1988

IR014141

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
James C. Alexander
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

BEST COPY AVAILABLE

The Fifth International Conference On Technology And Education

Volume 2

Edinburgh – March 1988

Editors:
J H Collins
N Estes
D Walker

ORGANISING COMMITTEE

David Walker Chairman, Scottish Council for Educational Technology, Glasgow

Jeffrey Collins Vice-Chairman, University of Edinburgh/University of Texas at Arlington

Paul Resta University of New Mexico, USA

Nolan Estes University of Texas at Austin, USA

Peter Ross University of Edinburgh, UK

William Gattis Tandy Corporation/Radio Shack Education Division, USA

Richard Rosser InterTAN, Inc., UK

Ron Hurley CEP Consultants, Ltd., UK

David Semple Lothian Regional Council, Edinburgh, UK

Betty Collis University of Victoria, Canada

Dale Doak University of Tennessee, USA

Co-Sponsors

University of Edinburgh
University of Texas
University of Tennessee
Scottish Council for Educational Technology (SCET)
Intenational Council for Computers in Education
InterTAN, Inc. (Canada, UK, Belgium)
Tandy Corporation/Radio Shack Education Division

© CEP Consultants Ltd 1988

Published by CEP Consultants Ltd, 26–28 Albany Street, Edinburgh EH1 3QH, UK

Printed in Great Britain by Page Bros (Norwich) Ltd.

CONTENTS

PLENARY SESSION

Page

Information Technology and Distance Education: The First 50 Years
T O'Shea 1

Classroom Computers in DoDDS: Past, Present and Future
J L Stremple, D L Bybee

SESSION 55: Artificial Intelligence/7

Building an Intelligent Tutoring System Within An Expert Systems Shell
R D Ward, I K Kirby, J B Smith, J Cramond, D H Sleeman, K Lowe 13

Expert Systems–A Competent Tool for Training
J Shaoul, P J Smith 17

Expert Systems for Computer-Based Training
D K Lidtke 22

SESSION 56: Teacher Education/5

Classroom Implementation of Advanced Personal Based Courseware Authoring Techniques
E D Doak, H L Martin 26

Maximizing Learning—by Doing: Teachers Author CAI Programs for Their Students
D H Judd, R C Judd 30

Computer-Controlled Video in Teacher Training
L D Brown, D H Gliessman 34

SESSION 57: Computers in the Classroom/12

The Effectiveness of Computer-based Instruction: A Review and Synthesis of Research from 1980–1987
M D Roblyer 38

Designing Community-Oriented Computer Education Programs: Lessons from Young Peoples University and Ysleta Intervention Projects
B E Wholeben 42

Computers in the Classroom
J DeWitt 46

SESSION 58: New Enabling Technologies/10

Planning, Piloting and Producing an Interactive Videodisc
J Mashiter 50

The Texas Learning Technology Group: Physical Science Project
C A Hardy 53

SESSION 59: Computers in the Classroom/13

The Development of a Simulated Business Entity as a Learning Vehicle
W Richardson, G J Worsdale 55

Page

Using the Technology of Online Financial Information in Teaching
T S Ho, S J McLeay, J O'Hanlon, R J Whiddett 59

Arabic by Computer
A A Brockett, O B Taylor 63

SESSION 60: Specialist Workshop/2

Towards an Evaluation of the Use of Information Technology in Curriculum Development Work
M Lincoln 67

*Computers in Third World Schools—Debugging the Wrong Approach to Make It Right for the 1990s
S Kirmani and M Kirmani 71

SESSION 61: Artificial Intelligence/8

Tutoring Strategies and Knowledge Engineering in a Wide Domain
T Fuller, A Slade 72

Automating the Teaching of Interviewing Skills
P Barker, R Mitra, D Woodhouse 76

SESSION 62: Teacher Education/6

Training Primary School Teachers to use Computers Effectively in the Classroom—an Investigation into Inservice Provision
M J Cox, V J Rhodes 80

Retraining Teachers in Low Demand Disciplines as Computer Learning Teachers
G G Bitter, R Sheets 84

Quenching the Thirst for Teacher Education: How, When and Where to Incorporate Software
K M Hurley, N B Fones, A V Kenyon 86

SESSION 63: Computers in the Classroom/14

Laboratory Work—How Computers Can Help
J M Queen 90

Computer Simulation of Laboratory Methodology in Pharmacology
D Wood, J M Noras 94

Developing Scientific Thinking Through The Use of Computer Monitoring
C T Opie 97

SESSION 64: New Enabling Technologies/11

*The Autotutor to CD-ROM: A Twenty Year, Personal Perspective on Technology in the Classroom
M L Harris 101

Interactive Video and Expert Systems
C P Tompsett 102

An Examination of Applications of New Information Technologies to Improve Instruction in Vocational Education and Training Programs
D D Gooler, G Roth 106

Page

SESSION 65: Computers in the Classroom/15

Software for Computer Aided Learning in Mathematics
C Beevers, B Cherry, D Clark, M Foster, G McGuire 110

Computer Aided Teaching of Microelectronics
C G Guy, M Howarth, S Kawar 114

K:AMP Alliance for Manufacturing Productivity. A Co-operative Project between Education and Industry
J Meloy 118

SESSION 66: Educational Administration/8

Evaluating Educational Technology
E G Kerr 122

Computerized Achievement Management System (CAMS)
G A Buckalter 126

SESSION 67: Open and Distance Learning/7

Teaching Programming at a Distance
A C Jones 130

Plugging the Classroom into the Community: Computer Networking in a Middle School
V E Baer 134

Retrospective Conversion: The Process and Product of Expanded Library/Media Resources
E K Browning 138

SESSION 68: Computers in the Classroom/16

PS 2000: An Action Plan to Educate Students for the 21st Century
M Gardner 142

Model Technology Programs: Lessons to be Learned From Existing Models in California
B Goodson 146

The Experiences of a Computers in Teaching Iniative Project
K J Day 150

SESSION 69: New Enabling Technologies/12

UNIX/XENIX and LANs—The Solution?!
M G Bailey 154

Logic Programming and Optical Disk Technologies in the Kellogg Project
E Sibert, A Shelly 158

A CAL Package to Link Semiconductor Process Engineering and ECAD
P R C Stevens, J M Noras 162

SESSION 70: Computers in the Classroom/17

Apples in the Guatemalan Highlands
P B Scott 165

Page

LABOR—Laboratory Environment for Learning Sciences
L A Barros 169

Philosophy of Technical Education
A L Arroyo 173

SESSION 72: Educational Administration/9

Building an Information Technology Infrastructure for the Polytechnic of Central London
E Sutherland, D Roberts, C Maslen, B Anrep, B Lowndes 177

Computers in Vocational Training—an Escalating Activity
R N Wilson 181

Discrete Formalisms and the Ensemble Modeling of the Instructional Process
P Prueitt 186

SESSION 73: Open and Distance Learning/8

CARTT: Computer Assisted Remote Television Teaching
A Shapiro 190

Distance Education—Planning and Practice
D C Holznagel 194

Television: Old Technologies and New Opportunities
R D Norman 198

SESSION 74: Educational Administration/10

Planning for the Utilization of Technology in Schools
S J Corda 202

Libraries and Information Technologies: To Be or Not To Be . . .
M D Boone, R W Collins 206

Developing a School System Computer Curriculum
P I Barrow 210

Strategies for Using Microcomputers in the Library
G Bartimas, N Bell 214

SESSION 75: New Enabling Technologies/13

The Impact of New Technology on the Accounting Curriculum
J Shaoul 218

A Report on Innovations in Computers in Education
D L Hosley 222

The Human Impact of Technology in Schools
B Hogins 226

SESSION 76: Computers in the Classroom/18

Graphs and Educational Computerization of Recreational Math
M A Murray-Lasso 230

Page

An Appropriate Continuum of Programs Leading to Information Processing Teacher Credentials: The Texas Model
D G Knezek 234

SESSION 77: Educational Administration/11

Applications of Microcomputers to Operations Research in Education
R G Taylor 238

Thinking With a Programming Language: An Introduction
H A Peelle 242

The Influence of the Interface on Information Retrieval
F M T Brazier, J J Beishuizen 246

SESSION 78: Educational Administration/12

Computer Use for Physicians: Fact and Fancy
W M Schmitt 250

A User Friendly End User Computing Course
K M O'Dubhchair 254

Technological Preparation of School Administrators in the US: Programs and Requirements
D W Spuck, W C Bozeman 258

Technical Preparation of School Administrators in the US: Course Structure and Content
W C Bozeman, D W Spuck 260

SESSION 79: Educational Administration/13

School Automation: A Paradigm for Analysis
J C Honeyman, D S Honeyman 263

Identifying Computing Priorities for Educational Policy Deveopment: Contrasting Unconstrained and Constrained Perceptions
B E Wholeben 267

Educational Computing Priorities for Policy Developments: A Systemic Study of Perceptions under Artificial Constraints
B E Wholeben 271

SESSION 80: Computers in the Classroom/19

Robotics: Human Resource Implications for Industrial America
H A Hunt, T L Hunt 275

Computers Across the Curriculum: Educational Leadership Vs School Administration
N Estes, B Curry, B Kennedy 279

SESSION 81: New Enabling Technologies/14

CD-ROM: A Technology for Education
D F Tanner 283

Page

SESSION 82: Computers in the Classroom/20

Graduate Distance Learning through Interactive Microwave Educational Centers
L A Zurfluh 287

Computing for the Terrified and the Merely Ignorant
J Darby 291

A Multi-Disciplinary Comprehensive Computer Applications Course
A C Krizan 294

SESSION 83: Artificial Intelligence/9

Turbo PROLOG Graphics as a Tool for Middle School Children to Learn the Constructs of PROLOG
G W Tubb 298

AI, Gadfly of Education
C Bollenbach 302

WORKSHOP DEMONSTRATIONS

GEMNET: A Global Communication and Information Network
W R Jacoby 306

The Applications of Telecommunications in Teaching/Learning Settings at the Secondary School Level
B Cates, N Bell 309

Elementary School Computer Labs
R S Pelfrey 313

Authoring With Pilot: An Introduction
R J O'Connor 317

Evaluating Computer-Integrated Learning Systems
K Harris 318

CADD Literacy: An Introduction to Personal Computer based Computer Aided Drawing and Design
J Meloy 321

From Kindergarten to Information Systems
R Dorfman 325

Two Promising New Applications of Technology for Improving Parent Involvement
J P Bauch 329

Teaching and Learning Styles: A Self Assessment Workshop
M K Minter, R L Minter 333

PLUTO—A European Network for Teacher Education
R Gwyn, N Longworth 335

AUTHORS—Volume 2

Anrep, B 177
Arroyo, A L 173

Baer, V E 134
Bailey, M G 154
Barker, P 76
Barros, L A 169
Barrow, P I 210
Bartimas, G 214
Bauch, J P 329
Beevers, C 110
Beishuizen, J J 246
Bell, N 214, 309
Bitter, G G 84
Bollenbach, C 302
Boone, M D 206
Bozeman, W C 258, 260
Brazier, F M T 246
Brockett, A A 63
Browning, E K 138
Brown, L D 34
Buckalter, G A 126

Cates, B 309
Cherry, B 110
Clark, D 110
Collins, R W 206
Corda, S J 202
Cotman, I L 275
Cox, M J 80
Cramond, J R 13
Curry, B 279

Darby, J 291
Day, K J 150
DeWitt, J 46
Doak, E D 26
Dorfman, R 325

Estes, N 279

Fones, N B 86
Foster, M 110
Fuller, T 72

Gardner, M 142
Gliessman, D H 34
Goodson, B 146
Gooler, D D 106
Guy, C G 114
Gwyn, R 335

Hardy, C A 53
Harris, M L 101
Harris, K 318
Hogins, B 226
Holznagel, D C 194
Honeyman, D S 263
Honeyman, J C 263
Hosley, D L 222
Howarth, M 114
Ho, T S 59
Hunt, H A 275
Hunt, T L 275
Hurley, K M 86

Jacoby, W R 306
Jones, A C 130
Judd, R C 30
Judd, D H 30

Kawar, S 114
Kennedy, B 279
Kenyon, A V 86
Kerr, E G 122
Kirby, I K 13
Kirmani, S 71
Kirmani, M H 71
Knezek, D G 234
Krizan, A C 294

Lidtke, D K 22
Lincoln, M 67
Longworth, N 335
Lowe, K 13
Lowndes, B 177

Martin, H L 26
Mashiter, J 50
Maslen, C 177
McGuire, G 110
McLeay, S 59
Meloy, J 118, 321
Minter, M K 333
Minter, R L 333
Mitra, R 76
Murray-Lasso, M A 230

Noras, J M 94
Norman, R D 198

O'Connor, R J 317
O'Dubhchair, K M 254
O'Hanlon, J 59
O'Shea, T 1
Opie, C 97

Peelle, H A 242
Pelfrey, R S 313
Prueitt, P 186

Queen, J M 90

Rhodes, V J 80
Richardson, W 55
Roberts, D 177
Roblyer, M D 38
Roth, G 106

Schmitt, W M 250
Shaoul, J E 17, 218
Shapiro, A 190
Sheets, R 84
Shelly, A 158
Sibert, E 158
Slade, A 72
Sleeman, D 13
Smith, J B 13
Smith, P J 17
Spuck, D W 258, 260
Stevens, P R C 162
Stremple, J 5
Sutherland, E 177

Tanner, D F 283
Taylor, O B 63
Taylor, R G 238
Tompsett, C P 102
Tubb, G W 298

Ward, R D 13
Whiddett, R J 59
Wholeben, B E 42, 267, 271
Wilson, R N 181
Wood, D 94
Woodhouse, D 76
Worsdale, G J 55

Zurfluh, L A 287

INFORMATION TECHNOLOGY AND DISTANCE EDUCATION: THE FIRST 50 YEARS

Tim O'Shea[1]

ABSTRACT

This paper very briefly reviews the early research and development work on computers in education in the fifties and sixties. It then deals with the applications of information technology to distance education in the seventies and eighties. It concludes with some speculations on the role that computers in particular and information technology in general may play in the development of distance education in the next thirty years.

INTRODUCTION

From the very start of civil computer science it was apparent to many psychologists, all cyberneticists and even a few computer scientists that this new technology would have an important role to play in education. In recent years the computer has become ubiquitous and we have started to use the term information technology to cover the progressively extended roles of hardware and software. Now we are in a position where educational systems do not have a choice about 'allowing the computer to enter the classroom' but at the same time much of the research that is most educationally valuable has not been applied in practice. Information technology seems particularly suited to the relatively modern (i.e. twentieth century) educational delivery system now known as distance education to which this short paper confines itself.

PRE-HISTORY

In the period to 1969 information technology was not applied to distance education. The researchers working in this period were all motivated by visions of adaptive interactive individualised instruction (a history of computers in education can be found in ref 2). In the fifties Skinner applied behaviourism to the design of 'teaching machines' and Pask applied cybernetics to the development of what we would now call learning environments. Skinner was a key pioneer who was followed in the sixties by Crowder, who introduced branching, Uttal who used algorithms in his teaching programs and Suppes who applied difficulty levels in his drill and practice programs. The most sophisticated piece of work that arose out of this style of work was Smallwood's 1962 experimental geometry tutor which improves the quality of its branching decisions through experience (ref 3).

The line of work started by Pask was much more concerned with the types of representational issues which now dominate artificial intelligence and work of a similar flavour in the sixties includes Feurzeig and Papert's LOGO language and various science simulations. By 1969 there was considerable experience with what we might call automated programmed learning texts and automated assessment. There was also some experience with programming languages designed for educational use such as BASIC

THE SEVENTIES

The various forms of distance education such as correspondence colleges and extension colleges in existence in the post war period had not made any great use of computers. When the Open University was founded in 1969 it used from the

---

[1] **Professor of Information Technology and Education**
Institute of Educational Technology, The Open University, Walton Hall, Milton Keynes MK7 6AA

outset a computer based system of student record keeping, a computer based continuous assessment system and (for a few courses) a computer marked examination system. Although the Open University was originally perceived as a 'television University' it has always been very eclectic and redundant in its use of technologies for the development and delivery of educational materials. A careful look at its system reveals more than twenty distinct technologies (with a very small 't') and my personal view is that its startling success in terms of low attrition, high growth, etc, etc., should not be ascribed to any particular magic ingredient but rather to the redundant mix of development and delivery technologies which provides robustness, meets the needs of very different types of students and facilitates continual experimentation and innovation.

The more mundane uses of computers have included fee collection, student progress monitoring and linking the regional offices located in the various parts of the country to the central database. Some science simulations were developed for offline use, the student posting parameters for a series of expensive or time consuming experiments to the central computer and receiving by return the record of the computer simulated some of the experiments. The seventies also saw considerable use of 'branching' computer assisted learning packages for remediation and the use of interactive programming languages such as BASIC and SOLO (a variant of LOGO for psychology students with various automatic aids and help facilities). These packages and languages were used via a national network of 260 computer terminals.

The most innovative system using this delivery mechanism was MERLIN a hybrid telephone/computer system which made it possible for a human tutor to intervene with spoken comments or for students to request help via the telephone during the use of an interactive physics teaching program. Interactive simulations that used graphical output were also developed in this decade but because of the costs of the delivery hardware their use was confined to residential summer schools.

The most interesting and innovative development in delivery technology was the O.U.'s microcomputer mailed to students for use during the year they studied the digital computer course provided by the Electronics Discipline. The microcomputer was lent to the students and was then checked before being reissued to another student. In some subsequent courses it made better economic sense for the microcomputer to be treated as a disposable item, like a book and or a correspondence text, for the student to retain or give to another student after the end of the course.

THE EIGHTIES

The single biggest change has been the cheap microcomputer. The Open University first took advantage of the spread of microcomputers by posting software to categories of students such as teachers who might have access to microcomputers. In 1988 a home computing policy was initiated which assumes that over the next few years an increasing proportion of students will have the sort of access to computers that they currently have to televisions and telephones (see Scanlon in this volume). The cheapness of the delivery technology and the increasing costs of software production have resulted in the increasing use by the Open University and other educational institutions of proprietory commercial software packages, for example for word processing, spread sheets and data base use.

A related general application of information technology for student use has been computer conferencing and electronic mail systems which support both formal and informal electronic meetings and bulletin boards. These have tremendous potential for a student body that is physically dispersed and very heterogeneous in age and background. Some interesting experiments have been carried out with videodisc technology at residential schools but the delivery hardware remains very expensive and the software production costs are high even compared to interactive computer tutors which typically require development ratios of two hundred professional hours to produce one hour's usable instruction. In addition there is still not a satisfactory single videodisc standard that can be followed by educational institutions.

The issue of standards is also causing acute problems in the area of electronic publishing. The logic behind applying electronic publishing to the production of printed distance education materials is impeccable. But each year sees new changes, more powerful hardware and a continual battle between different software standards. The result is that the economic risks associated with equipping a large staff (over 1,000 being directly associated in some way with materials production at the Open University) are acute.

Ideas and developments from artificial intelligence research continue to trickle into educational practice. The adaptive teaching programs have become more sophisticated in their adaptive capability, pupils errors are modelled to student teachers in a mathematics instruction course and an augmented version of the artificial intelligence language PROLOG is used in some undergraduate and post graduate courses.

I consider the single most important development in the eighties to be the use of computer based aids for students with special needs (see Edwards in this volume). For example the use of speech synthesizers by blind students. As far as the educational quality of the materials used in the eighties goes there has not been much development since the previous decade, the bulk of the effort going into meeting the challenge posed by the new cheap microcomputer delivery technology. As in the seventies there have been a few experiments with hybrid technologies such as CYCLOPS. CYCLOPS makes it possible for groups of up to twenty physically dispersed students to annotate and talk about shared free hand sketches or computer generated images. It is based on conventional telephone and television equipment but requires the use of a special purpose microcomputer based communications device.

Many of the recent developments at the Open University are discussed in reference 1. At the time of writing we are in a position where IT hardware is cheaper and more widespread than almost anybody would have predicted but nearly all the software is less educationally sophisticated that the best prototype systems produced before 1975.

THE NEXT THIRTY YEARS

In this period we can assume that all students will come to have in their homes computer workstations with at least the communication, storage, processing and display capabilities of the high performance artificial intelligence workstations of today. I would expect to see intelligent tutoring systems incorporating student models for two types of teaching domain. Firstly those like medicine or business studies where there are strong non-educational drives behind the production of expert systems. Secondly domains like basic mathematics which have high educational priority and can thus attract the resources necessary to support the basic research needed. The sub-area of artificial intelligence which is key to the development of intelligent tutoring is machine learning and perhaps in fifteen years time we will see practical use of the types of self-improving tutors prototyped fifteen to twenty-five years ago.

The other main type of contribution to improved educational quality is the development of computer simulations for domains such as physics and music that can be directly manipulated. The pioneering work of the group led by Kay and Goldberg at Xerox PARC with Smalltalk-72 and the subsequent object-oriented programming environments such as ARK, Randall Smith's Alternate Reality Kit, show us what can be done using this powerful and general approach to modelling the world. Another important area is the authoring of computer based teaching materials. The current generation of authoring systems is quite unsatisfactory but there is the promise of new systems which use artificial intelligence techniques to model both the design and the delivery functions.

Many of the existing hardware standards (e.g. the eight bit micro and the current videodisc standards') will prove to be ephemeral and the key issue for distance education is taking advantage of those technologies that enter the majority of homes and adopting software standards that will outlive the obsolescence of particular systems of hardware. Looking over the past twenty years the most striking original contribution of distance education to information technology has been the hybrid systems such as MERLIN and CYCLOPS that marry computer technology to conventional communications technology. These different information technologies will continue to converge and I would expect to see the increasing use of hybrid systems with students in the space of a single lesson (of one hour say), switching repeatedly between computer program use, spoken speech, two way video and the use of personal databases. One trend that I expect to blossom is collaborative work (both synchronous and asynchronous) between groups of students mediated by the new information technologies. So instruction will become even more adaptive but also rather less individual.

CONCLUSION

I have concentrated on the British Open University because given its size and diversity it encompasses most of the ways information technology are applied to distance education. But I should emphasise that there are many other distance learning institutions using IT in innovative ways around the world.

We now have a good feel for the time lag between the implementation of advanced prototypes based on artificial intelligence and cybernetics and their successful application in day to day education. In thirty years time we can hope that more of the educationally exciting ideas of visionaries like Pask, Smallwood and latterly Randall Smith will be applied in distance education. At the same time it would seem very surprising if much of the contemporary research into, for example, parallel hardware or logic based programming languages reached sufficient maturity to be applied in education before 2020.

By 2020 I would expect there to be some very educationally advanced tutoring systems and direct manipulation simulation environments and a widespread general educational benefit resulting from the communication functions associated with the new information technologies. The principal beneficiaries will be students who will be able to collaborate closely in educational endeavours despite being dispersed from each other in terms of both physical location and time of active studying.

REFERENCES

1. Jones, A., Scanlon, E .and O'Shea, T. 'The Computer Revolution in Education : New Technologies for Distance Teaching' (Harvester & St. Martins Press, 1987).

2. O'Shea, T. and Self, J. 'Learning and Teaching with Computers: Artificial Intelligence in Education' (Harvester 1983, Basic Book 1984).

3. Smallwood, R.D., 'A Decision Structure for Teaching Machines, (Cambridge, MIT Press. 1962).

CLASSROOM COMPUTERS IN DoDDS[1]: PAST, PRESENT, AND FUTURE

Dr. John L. Stremple, Director, DoDDS

Dr. Dennis L. Bybee, Chief, MIS Division, DoDDS

ABSTRACT

The DoDDS experience with computers in the classroom runs parallel to similar programs operated by school districts throughout the United States and has evolved through three distinct phases. This paper identifies, describes, and - through the DoDDS example - explains key features of each of these phases as they evolved and developed in the 1970s and 1980s. Key issues are suggested for the 1990s (phase four in the development of classroom computing in the United States.)

INTRODUCTION

Classroom computing in American is now poised upon the threshold of what might be the most dramatic innovation in American education since the development of the "factory model" school which accompanied the industrial revolution (ref 2).

The Forecast:

In the 1990s, what has been a major effort to introduce students to computer technology in the 1970s and 1980s (variously labeled informatics, computer literacy, or computer science) will give way to dramatic and pervasive classroom uses of computer technology as an instructional methodology.

To understanding this forecast, it is important to recognize what has brought us to this threshold, what we have done along the way, and what we are likely to see happen - or need to have happen to ensure success in the 1990s.

The Phases:

The path we've followed began with an **Experimentation Phase** which took place in the 1970s. It entered an **Expansion Phase** which lasted for about 4 years from 1980 to 1984. The current **Evaluation/Planning Phase** began in 1985 and will end when computer technology starts becoming available to all students in the classroom. It is anticipated that universal availability of computer technology will be accomplished during an **Implementation Phase** which will continue in the United States throughout the 1990s.

PHASE I: EXPERIMENTATION

This phase was characterized by building teacher awareness of computer possibilities and by a developing effort on the part of administrators to get a computer into the school. These tendencies are mirrored in the statistical reports of the period. In 1975, the American Institute for Research (AIR) reported that 25% of the school districts in the United States provided student access to at least 1 computer for instructional uses. The predominant question was "**How many schools have computers?**"

In DoDDS, teacher and curriculum coordinator efforts were documented in the first DoDDS "possibilities model" for computer education which was created and published in 1978. (See figure 1). This model recognizes that there are basically three possibilities. You can **teach about** computers [COMPUTER INSTRUCTION], you can **teach with** computers [COMPUTER APPLICATION], and you can use computers to **manage** the educational process [ADMINISTRATION].

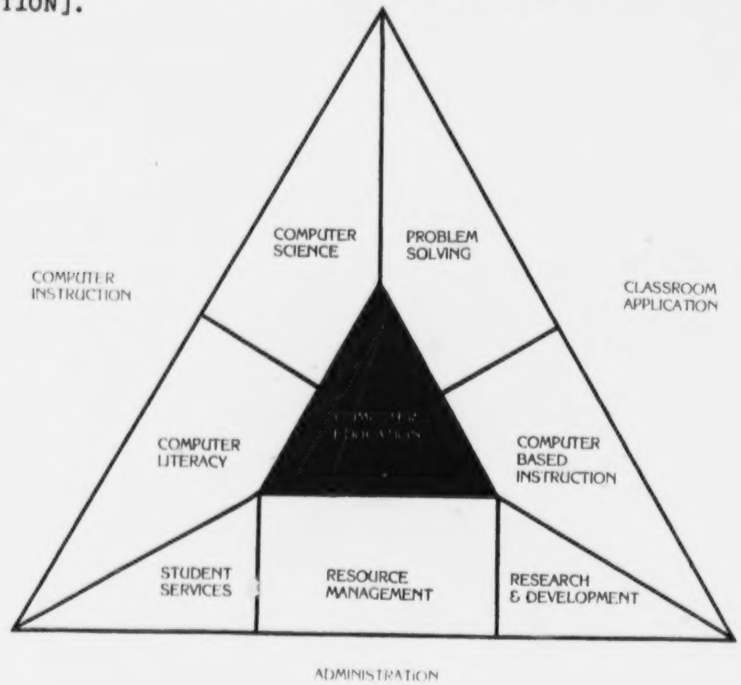

COMPUTER INSTRUCTION
CLASSROOM APPLICATION
COMPUTER SCIENCE
PROBLEM SOLVING
COMPUTER EDUCATION
COMPUTER LITERACY
COMPUTER BASED INSTRUCTION
STUDENT SERVICES
RESOURCE MANAGEMENT
RESEARCH & DEVELOPMENT
ADMINISTRATION

Figure 1. DoDDS Computer Education Program [1978]

In 1978, DoDDS set only one objective for the computer education program. It was that "... DoDDS is committed to the **establishment of a computer education program** which will meet the needs of all students within the geographically dispersed regions."

DoDDS efforts during this period were directed toward acquiring computers for secondary schools and calculators for elementary schools. At the end of this period, DoDDS was only able to provide computer access to students in the larger secondary schools where the joint administrative and instructional computing requirements could justify the acquisition of small - but very expensive - minicomputers.

The end of the experimental phase was signaled when low cost microcomputers became available in the consumer market [e.g., Apple, Commodore Pet, and the TRS-80.] In the latter 1970s, these introductions presented educators with a combination of **user control** and **low cost** which was irresistible. The rush was on to get more computers into the classroom.

PHASE II. EXPANSION

In 1980, the [American] National Council of Teachers of Mathematics (NCTM) published "An Agenda for Action" with 8 recommendations for school mathematics of the 1980s (ref 3). The Council recommended that "mathematics programs take full advantage of the power of calculators and computers at all grade levels." This statement crystallized many school district efforts and the period of expansion was formally announced. In fact, many school districts in the United States were already moving in this direction (ref 4). [DoDDS had already included a K-12 strand on "computer literacy" in its published scope and sequence of mathematics objectives and had purchased hand held calculators for use in all classes at grades 5-8.]

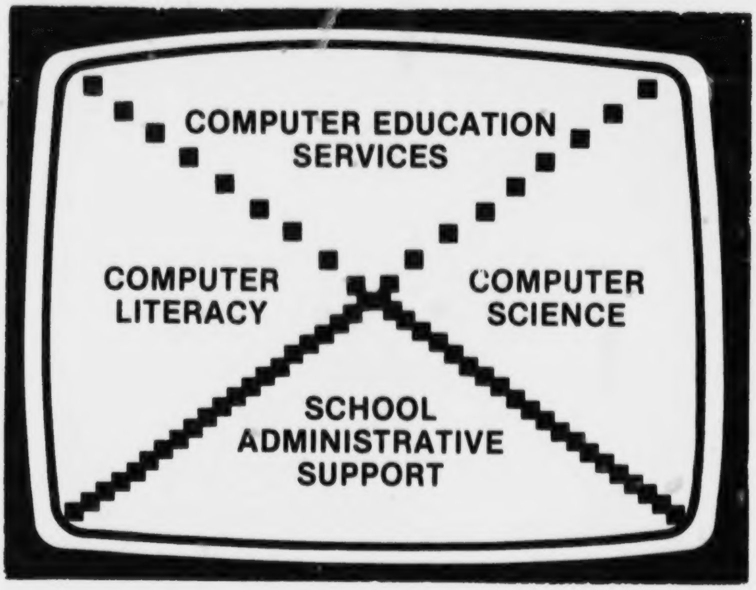


Figure 2. DoDDS Educational Computing Program [1982]

DoDDS published the first comprehensive set of instructional objectives for computer literacy and computer science instruction at all grades (K-12) in January 1982. Building on the previous "possibilities model" for computer education, the new model (Figure 2) focused on computer literacy and computer science. Major goals, program and instructional objectives were written and the grade levels for introduction and student proficiency was expected were identified. A great deal of curriculum development effort followed in the wake of this publication.

In 1982, DoDDS worked with the North-West Regional Educational Laboratory (Portland, Oregon) and developed a test item pool and criterion referenced tests for computer literacy at grades 4,7,11 and a computer science test for high school students who had taken at least one high school data processing course. Baseline data was gathered from school districts around the United States [including state-wide testing in California]. DoDDS student scores were comparable to the sampling of better school districts [i.e., districts recognized as having good computer literacy/computer science programs] and well above the averages on all tests by students in the random sample of California students.

Each of the 5 DoDDS regions developed curriculum guides to implement the world-wide objectives and secondary courses and elementary classroom activities were developed and implemented.

During this phase, DoDDS began hiring teachers with specific training in computer programming to teach secondary computer science courses. Teachers attended school year and summer workshops in large numbers. Elementary school teachers began developing computer learning activities and cardboard box models of computers sprang up everywhere.

DoDDS' earlier frustrations with limited equipment access continued in spite of an acquisition of 1,374 classroom microcomputers in 1982. These computers were placed in schools according to a distribution formula based on type of school and size. Secondary schools got more computers than elementary schools (which reflected the early emphasis on computer science instruction) and larger schools got more computers than smaller schools. All schools got some computers. No one got enough; because student interest and course enrollments increased far beyond initial projections. By 1982, DoDDS had about one computer for each 125 secondary students and only 3.6% of the elementary students had access to computers in the classroom. The acquisition of 500 more computers in 1983 only increased the demand for more.

This DoDDS experience was reflected in several national reports for the period. In 1982, the National Center for Educational Statistics (ref 5) reported that 50% of the school districts provided student access to at least one computer. (This was twice the 1975 AIR figure.) The United States Office of Technology Assessment reported in September of 1982 that the information revolution was "creating stress on schools", that "an information technology role was "already established for education and training", that "information technology holds promise of being a major vehicle for education and training", and that "much remains to be learned about the effects of [the] technological approach to education and training."

In 1983, the national Commission on Excellence in Education signalled the beginning of the end of the expansion period when it recognized serious deficiencies in American education and recommended that "state and local high school graduation requirements be strengthened and that, at a minimum, all students [take] one-half year of computer science" (ref 6).

In the Nov./Dec. 1983 issue, the Electronic Learning magazine published its "Third Annual Survey of the States" (ref 7) which chronicled this expansion phase in its subtitle as "What the 50 State Governments Are Doing to Promote Educational Computing - and How They're Doing It." [This forum promoted competition among the States to see who would be first in computer education and no one wanted to be last!] Most school districts did respond to this kind of public pressure. Only our poorer states and states with other priorities (e.g., Hawaii) failed to respond with state mandates and funds.

Since most schools already had computers, the primary measure of commitment to educational computing in America became **the number of students per computer**. In November 1985, Quality Education Data of Denver, Colorado (ref 8) conducted a Survey of States and reported Alaska on top with 17:1. Wisconsin and New York were at the median; each with 49:1. Hawaii was at the bottom with a ratio of 86:1. At 67:1, DoDDS computer acquisitions had obviously not kept pace with other school districts in America. (See Figure 3.)

Figure 3. Ranking of States by Average Ratio of Students/Computer

RANK	STATE	STUDENTS/ COMPUTER	RANK	STATE	STUDENTS/ COMPUTER
1	ALASKA	17:1	27	TEXAS	50:1
2	RHODE ISLAND	21:1	28	MICHIGAN	51:1
3	MINNESOTA	30:1	29	NEW JERSEY	51:1
4	WYOMING	30:1	30	OKLAHOMA	51:1
5	SOUTH DAKOTA	34:1	31	ILLINOIS	55:1
6	COLORADO	35:1	32	IDAHO	55:1
7	OREGON	35:1	33	NORTH CAROLINA	55:1
8	NEW MEXICO	36:1	34	PENNSYLVANIA	56:1
9	WASHINGTON	38:1	35	MARYLAND	56:1
10	CONNECTICUT	39:1	36	MAINE	56:1
11	NEBRASKA	40:1	37	SOUTH CAROLINA	57:1
12	INDIANA	40:1	38	VIRGINIA	58:1
13	DISTRICT OF COL.	41:1	39	TENNESSEE	58:1
14	FLORIDA	42:1	40	KENTUCKY	58:1
15	KANSAS	43:1	41	DELAWARE	60:1
16	WEST VIRGINIA	43:1	42	ARKANSAS	60:1
17	MASSACHUSETTS	44:1	43	CALIFORNIA	61:1
18	MONTANA	45:1	44	OHIO	63:1
19	ARIZONA	45:1	45	MISSOURI	63:1
20	NORTH DAKOTA	45:1	46	ALABAMA	64:1
21	IOWA	46:1	47	NEW HAMPSHIRE	67:1
22	UTAH	48:1	48	DoDDS	67:1
23	VERMONT	48:1	49	GEORGIA	75:1
24	NEVADA	48:1	50	MISSISSIPPI	77:1
25	WISCONSIN	49:1	51	LOUISIANA	84:1
26	NEW YORK	49:1	52	HAWAII	86:1

PHASE III. EVALUATION/PLANNING

Phase III begins when a school district recognizes that the race to have the best students/computer ratio assumes that schools need one computer for each student (ref 9). The question of individual cost and "If not one, then how many and for what?" leads inevitably to an **evaluation** of needs. For DoDDS, this started in 1984 and by 1985, the apparent answer was that "about 1 computer for every 5 students" is needed to address the computer-based instruction requirements of all subject areas (K-12). And, all subject areas want to be addressed - simultaneously!

To address all curricular areas simultaneously would require fiscal resources well beyond those available to most school districts (i.e., about 40 to 50 million dollars would be needed for DoDDS). Also, the impact of such a large expenditure is very uncertain.

In 1985, Henry Jay Becker of the Center for Social Organization of Schools at The Johns Hopkins University in Baltimore, Maryland conducted a national survey of over 2,100 schools in America and concluded that "... schools will use computers in almost all facets of teaching" and that "the proliferation of computers in classrooms across the county will continue over the next few years, despite the inability of education experts to provide conclusive evidence that computers really help children scholastically" (ref 10).

In view of these uncertainties, DoDDS educators developed a **plan** to distribute computer resources to schools according to the pre-determined workstation distribution criteria; but to establish **demonstration projects** and conduct an **evaluation** of how appropriate computer technology is in each curricular area before beginning implementation in any specific area. Pilot projects have been established in all of the five DoDDS regions as shown on figure 4.

Figure 4. CBI Demonstration Projects

SUBJECT		AT		GE		ME		PA		PN		TOTAL	
		PROJ.	CPU	PROJ.	CPU	PROJ.	CPU	PROJ.	CPU	PROJ.	CPU	PROJ.	CPU
KN	Kindergarten			2	(4)	2	(6)			1	(3)	5	(13)
01	Grade 01 Course			8	(24)					1	(3)	9	(27)
02	Grade 02 Course			13	(39)					2	(6)	15	(45)
03	Grade 03 Course			8	(24)					1	(3)	9	(27)
04	Grade 04 Course			12	(36)					1	(3)	13	(39)
05	Grade 05 Course			8	(24)					4	(12)	12	(36)
06	Grade 06 Course			7	(21)					2	(6)	9	(27)
07	Grade 07 Course	1	(3)									1	(3)
AR	Art	4	(8)	8	(16)	3	(6)	3	(6)			18	(36)
BA	Basic Allocation			7	(21)	13	(39)	4	(12)			24	(72)
BE	Business			4	(12)	2	(6)					6	(18)
CE	Compensatory Education			10	(30)	2	(6)	2	(6)	1	(3)	15	(45)
CO	Cosmotology			1	(2)	1	(2)					2	(4)
CS	Computer Literacy	2	(42)	9	(131)	1	(3)			1	(3)	13	(179)
CW	CWE			2	(4)	1	(2)	2	(4)			5	(10)
EP	Educ. Prescriptionist									1	(1)	1	(1)
ES	ESL			12	(12)	2	(2)	7	(7)			21	(21)
EV	Evaluation			2	(2)			3	(3)			5	(5)
FL	Foreign Language	1	(4)	3	(12)	1	(4)	2	(8)			7	(28)
GT	TAG	2	(4)	19	(38)	2	(4)	7	(14)	2	(4)	32	(64)
GU	Counseling	1	(1)			5	(5)	2	(2)	1	(1)	9	(9)
HE	Home Economics	1	(3)	2	(6)	1	(3)					4	(12)
HL	Health			4	(8)	1	(2)			1	(2)	6	(12)
HN	Host Nation			3	(10)							3	(10)
IA	Industrial Arts	1	(6)	1	(6)	1	(6)					3	(18)
LA	Language Arts	10	(30)	44	(130)	4	(12)	24	(72)	3	(9)	85	(253)
MA	Mathematics	10	(30)	31	(93)	6	(18)	16	(48)	1	(3)	64	(192)
ME	Media	1	(2)	24	(48)	2	(4)	4	(8)	1	(2)	32	(64)
MU	Music	1	(1)	10	(11)	3	(3)	2	(2)			16	(17)
PE	Physical Education			1	(2)	1	(2)	1	(2)			3	(6)
PP	PPS			14	(19)			1	(1)			15	(20)
RE	Reading	1	(2)	23	(46)	2	(4)	6	(12)			32	(64)
SC	Science	6	(18)	21	(63)	3	(9)	13	(39)	2	(6)	45	(135)
SE	Special Education	8	(8)	26	(26)	4	(4)	8	(8)	7	(7)	53	(53)
SS	Social Studies	5	(15)	15	(45)	2	(6)	11	(33)	2	(6)	35	(105)
VE	Vocational Education			7	(18)	1	(2)	2	(7)			10	(27)
TOTAL		55	(177)	361	(983)	66	(160)	120	(294)	35	(83)	637	(1697)

DO	District Office		(4)		(8)				(4)				(16)
RO	Regional Office		(2)		(15)		(3)		(2)		(3)		(23)

SCHOOL PARTICIPATION	33	138	23	41	10	245

Nov 4, 1987

In all, 1,700 additional microcomputers are being distributed among 245 schools which are participating in these projects during school year 1988-89. Project results will be used in revising the workstation distribution criteria and in establishing priorities for implementation among the curricular areas in the 1990s.

Expansion continues in DoDDS and throughout the United States during the evaluation/planning phase. In DoDDS, acquisition of computer classroom resources continued even as educators were making plans for pilot operations and evaluation during school year 1988-89. The DoDDS students/computer ratio improved as follows:

DATE	DoDDS	FLORIDA	MARYLAND P.GEORGE	COUNTIES MONTGOMERY	FAIRFAX CO (Ref 11) VIRGINIA
1985	67:1	42:1	NA	NA	NA
5/87	47:1	26:1	NA	NA	NA
12/87	42:1	NA	20:1	20:1	35:1
S/88	30:1	NA	NA	NA	NA

By 1990, it is expected that most school districts will have identified specific classroom activities where the use of computer-based instruction (CBI) methodology can enhance student learning capacity. DoDDS expects to have a clearer picture of its own requirements when CBI demonstration project results are compiled in the spring of 1989. The findings and recommendations coming out of this DoDDS' project will provide program direction for the use of computers in classrooms throughout the 1990s.

PHASE IV. IMPLEMENTATION

Assuming that the use of computer technology as a medium of instruction can be shown to be effective, it is anticipated that classrooms will change dramatically in the 1990s. Every classroom could have as few as 5 or as many as 25 computer workstations. Popular methodologies will include individualized instruction, independent study, open learning, team teaching, cross-age tutoring and others which focus on small group or individual needs. The teacher's role will gradually become that of a manager of the learning environment and **many more educators will be needed** to effect a "high touch" climate in the "high tech" environment (ref 12).

In addition to effectiveness, the following issues must be resolved before schools can successfully move forward in the implementation phase:

1. **Curriculum Integration.** Whether computer-based learning is used to supplement, reinforce, or substitute for current instructional activities, the content of the learning has to be consistent with the overall learning objectives of the curriculum.

2. **Universal Availability of Computer Workstations.** Computer hardware must become smaller, cheaper, and interoperable among different manufacturers.

3. **Transportability of Software.** Software must become as simple to operate as opening a book and with virtually no user training.

4. **Teacher Training.** Teacher training institutions must incorporate computer-based instruction as an instructional methodology in their own preparation of classroom teachers. In-service training activities must focus on the integrated curriculum (including computer-based instruction activities) rather than upon the computer as an instructional device. [Using computers should have no more emphasis than is currently given to the use an overhead projector.]

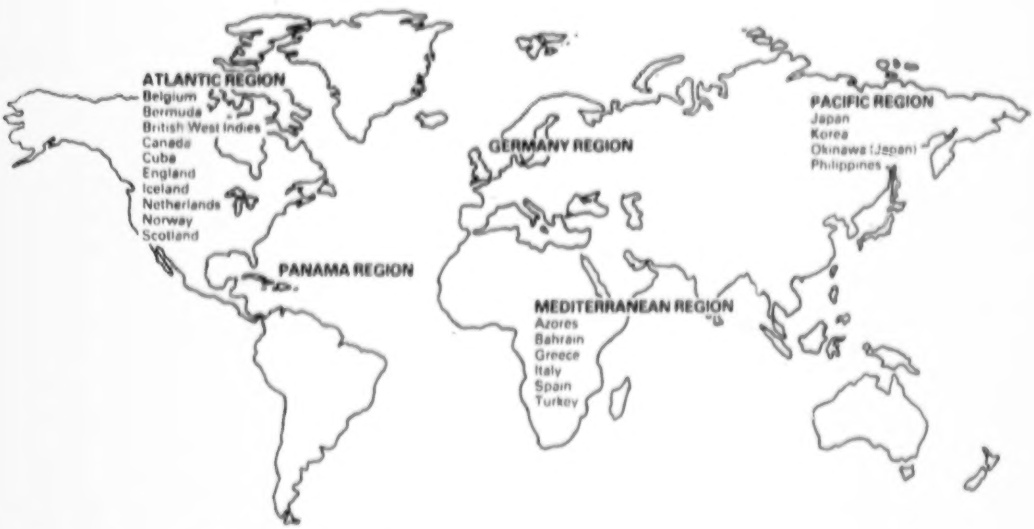
5. **Working Together.** Obviously, these issues cannot be resolved by educators alone. Resolution will depend upon the computer equipment manufacturers, software developers, textbook publishers, and the public. Unfortunately, no forum currently exists within which all of these

ingredients can be brought together for the good of the medium. This is the final and most pressing issue. **ALL OF THE AFFECTED GROUPS MUST WORK TOGETHER TO RESOLVE THESE CRITICAL ISSUES FOR IMPLEMENTATION TO TAKE PLACE IN THE 1990s.**

REFERENCES

1. Department of Dependents Schools (DoDDS) operates 270 American-style, elementary and secondary schools (K-12) in over 22 countries for the benefit of approximately 156,000 dependents of United States military and civilian personnel stationed outside the continental United States.

DoDDS REGIONS


ATLANTIC REGION
Belgium
Bermuda
British West Indies
Canada
Cuba
England
Iceland
Netherlands
Norway
Scotland
GERMANY REGION
PACIFIC REGION
Japan
Korea
Okinawa (Japan)
Philippines
PANAMA REGION
MEDITERRANEAN REGION
Azores
Bahrain
Greece
Italy
Spain
Turkey

2. Toffler, Alvin, Future Shock, Bantom Books, 1970, Chapter 18
3. NCTM, "An Agenda for Action", Reston, VA, 1980
4. Gibbons, John H., "Information Technology and Its Impact on American Education", Office of Technology Assessment, US Congress, 1980, pg. 9
5. NCES, U.S. Dept. of Education, "Instructional Use of Computers In Public Schools", Sept. 7, 1982
6. "A Nation At Risk", The National Commission on Excellence in Education, David P. Gardner, April 1983.
7. Christen & Gladstone, "EL's Third Annual Survey of the States", Electronic Learning, November/December 1983
8. Quality Education Data, "November 1985 Survey of States", Denver, CO, 1986
9. "Batting Nine Hundred", Electronic Learning, May/June 1986, pg. 6
10. Becker, Henry Jay, "Instructional Uses of School Computers", Reports from the 1985 National Survey, Issue #3, Nov. 1986, The John Hopkins University
11. Folks, Mike, "Computers Changing Direction of Teaching", The Washington Times, December 23, 1987, pg. B-2
12. Naisbitt, John, Megatrends, Warner Books, 1982, Chapter 2

BUILDING AN INTELLIGENT TUTORING SYSTEM WITHIN AN EXPERT SYSTEMS SHELL

R.D.Ward+, I.K.Kirby+, J.B.Smith*, J.R.Cramond*, D.Sleeman+, K.Lowe*

ABSTRACT

Intelligent Tutoring Systems (ITSs) are one particular type of expert system. Tools for building expert systems should therefore be useful for building ITSs. The presentation will discuss some of the problems encountered in using a general purpose knowledge engineering tool (S.1) for building an ITS to help trainee oil platform operations technicians to develop their fault-finding skills. The system is still under development.

Intelligent Tutoring Systems (ITSs) are one particular class of expert system. In fact they may be considered to possess several associated areas of expertise covering the subject domain, the student, teaching operations and teaching decisions - i.e. the matching of teaching operations to students (ref 1).

Expert systems shells were devised to facilitate the building of expert systems by providing ready-made knowledge representation and reasoning mechanisms. They will not be perfectly suited to every application - there may be aspects of a particular expert system that would be better implemented using techniques not provided by a particular shell. However, the advantages of shells can often outweigh the disadvantages. Given this compromise, expert systems should be useful in building ITSs.

One such shell is S.1, a knowledge engineering language originally developed by Teknowledge in California. S.1 was originally implemented in Lisp, but a second, faster, portable version has now been implemented in C. The project described in this paper is using the C implementation (Version 2.2 under UNIX on a SUN 3/160).

S.1 was strongly influenced by the Stanford Heuristic Programming Project, and therefore contains many ideas originating in MYCIN (ref 2). It is oriented towards rule-based representation of knowledge, but also supports frame-based and procedure-oriented representations. Its principal characteristics include a backward chaining control scheme, built-in certainty handling mechanisms, control blocks that support procedure-oriented representation and programming methods, and inbuilt explanation mechanisms. (See refs 3 and 4 for further details).

In the current project, S.1 is being used to develop an ITS for use in the Shell Expro Technicians Training Scheme (SETTS), a three-year, full-time, in-service training course for oil platform operations technicians, run by Shell U.K. Exploration and Production in collaboration with Aberdeen Technical College. The course is multidisciplinary, covering electrical, mechanical, instrument and process engineering.

+Department of Computing Science, University of Aberdeen. AB9 2UB.
*Shell U.K. Exploration and Production, Nigg, Aberdeen. AB9 2HY.

SETTS operates EAGLE, an onshore, working mock-up of an oil platform occupying approximately a half-acre site. This is an expensive and unique piece of training equipment, but a limited resource, and thus the amount of time trainees may spend on EAGLE must necessarily be limited. This particularly affects their practise of fault diagnosis skills, where one trainee may require much of the platform to himself. Computer simulation appears to be one way of extending this resource.

Many previous ITSs have incorporated simulation. Perhaps the best known example is SOPHIE (ref 5), which taught electronic circuit troubleshooting by selecting one of a predetermined set of faults, and then allowing the student to ask a series of questions to find the fault. SOPHIE was, however, a hand-crafted system with its tutoring components implemented in INTERLISP, and its circuit simulation in FORTRAN. It predated many developments in the expert systems field, in particular expert systems shells.

GUIDON (refs 2,6), an ITS which instructed students in the selection of antimicrobial therapy for patients with bacterial infections, was developed within the mainstream of expert systems research. GUIDON selected a case, solved it, presented it to the student to solve, and analysed the student's responses and queries during the solution process. Differences between the student's and the system's diagnosis procedures were used to guide tutoring and explanation mechanisms.

GUIDON used the MYCIN knowledge base. This was augmented by domain meta-rules and by tutoring rules. It demonstrates the kind of ITS that might be implemented within an expert systems shell. However, its domain knowledge modelled the heuristic reasoning of expert diagnosticians, rather than quantitative simulation as in SOPHIE.

More recently, White and Frederiksen (ref 7) have developed ITSs containing qualitative simulations of electrical circuits. Each component of a circuit is represented by a rule-based model that allows the state of the component to be re-evaluated whenever there is a change in the voltage applied to it, which in turn may affect its conductivity, or its status as a voltage source, and hence the voltages applied to other components. It should be possible to implement this kind of simulation within a rule-based expert systems shell.

In the present ITS project, the domain knowledge consists of a rule-based simulation of a typical oil-platform motor control circuit. These circuits consist of a number of electro-mechanical components, for example switches, fuses, sensors, cut-outs, relays and indicator lights, which control the power supply to the powerful electric motors that drive water pumps and drilling machinery. Circuits and components are prone to fault because of the extreme offshore weather conditions. The circuit logic is often complex, and fault diagnosis can be difficult, time consuming, and also costly if there is lost production. Figure 1 shows a simple motor control circuit. Real life circuits are more complex than this, perhaps containing five or more motors and 1,000 or more components, but the principles are the same.

With S.1 we have simulated circuits containing around 100 components. The simulation allows the user to collect observations at several points in the circuit corresponding to the real-life observations that would be

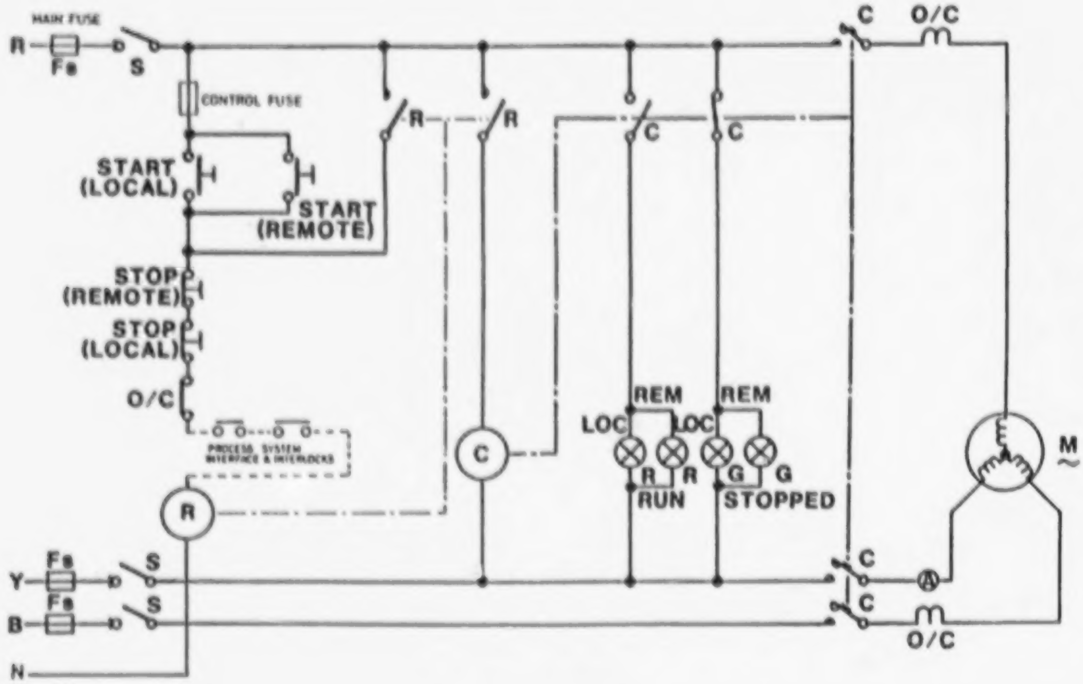

MAIN FUSE
R
Fs
S
CONTROL FUSE
START (LOCAL)
START (REMOTE)
STOP (REMOTE)
STOP (LOCAL)
O/C
PROCESS SYSTEM INTERFACE & INTERLOCKS
R
R
R
C
C
C
O/C
REM
REM
LOC
LOC
R
R
G
G
RUN
STOPPED
M
~
Y
B
N
Fs
Fs
S
S
C
C
A
O/C

Figure 1: A simple motor control circuit.

available to an engineer. The user may also alter the behaviour of the circuit through simulated controls or by replacing components, again as would be possible in real life. This, on its own, allows trainees to open-endedly explore the operation of the circuit. Problem driven learning is also possible, in which the trainee practises the diagnosis and correction of unknown faults by collecting observations and taking actions.

It is also planned to build into the system a simulated expert fault finder. This will allow the trainee to observe an articulate expert carrying out the diagnosis of faults introduced by the trainee. This expertise will be in the form of a conventional, rule-based expert system.

Because the ITS is implemented in an expert systems shell, the user will have access to inbuilt explanation mechanisms. This will allow questions to be asked about how particular values within either the simulated motor control circuit or the simulated expert have been determined; for example, "How is it known that there is no potential at a particular point" or "How did the expert deduce that a particular component was faulty".

It is planned to investigate the use of the system in the different kinds of learning activity mentioned above, and also to examine the adequacy of the inbuilt explanation mechanisms for tutoring. The system will also need to be able to recognise trainees' efficient and inefficient fault-finding strategies and to provide appropriate commentary.

The project will determine how possible it is to implement these several facilities within the S.1 shell.

REFERENCES

1. J R Hartley and D Sleeman, Towards Intelligent Teaching Systems, Int. J. Man Machine Studies, 5, pp 215-236 (1973).

2. B G Buchanan and E H Shortliffe, Rule-Based Expert Systems. The MYCIN Experiments of the Stanford Heuristic Programming Project (Addison-Wesley, Reading, Mass, 1984).

3. R D Ward and D Sleeman, Report AUCS/TR8714, Learning To Use the S.1 Knowledge Engineering Tool, Dept Computing Science, University of Aberdeen (1987).

4. R D Ward, Report AUCS/D8702, Getting Started with the S.1 Knowledge Engineering Tool, Dept Computing Science, University of Aberdeen (1987).

5. J S Brown, R R Burton and J DeKleer, Pedagogical, natural language and knowledge engineering techniques in SOPHIE I, II and III, Chapter 11 in D Sleeman and J S Brown (Eds), Intelligent Tutoring Systems (Academic Press, London, 1982).

6. W J Clancey, Tutoring rules for guiding a case method dialogue, Int. J. Man Machine Studies, 11, pp 25-49 (1979).

7. B Y White and J R Frederiksen, Causal Model Progressions as a Foundation for Intelligent Learning Environments, Report 6686, BBN Laboratories, Cambridge, Mass. (1987).

EXPERT SYSTEMS - A COMPETENT TOOL FOR TRAINING?

J.E. SHAOUL*, P.J. SMITH*

ABSTRACT

Expert systems, rule based knowledge systems, have been widely heralded as an important tool in management and accounting. Expert system shells have become available for personal computers, and accountants are investing in systems which are supposed to be capable of intelligent decisions. The limitations of rule based knowledge systems are discussed and illustrated by means of an expert system built to calculate and diagnose standard cost variances. This paper argues that such a system is, at best, because of the nature of human intelligence as intuitive and reasoning, rather than rule based, a proficient or competent system, and discusses the limitations and applications of expert systems, particularly in relation to training, in the light of these experiences.

INTRODUCTION

The advent of relatively cheap personal computers and the associated software have changed the nature of computer usage in business and management. Whereas mainframe applications were directed towards transaction processing, eg. payroll, and information systems for control, eg. stock control, the new technology emphasises, as evidenced by the widespread use of spreadsheets, decision support systems for planning.

There has therefore been in business education an increase in interest in how to train managers/accountants in decision making skills rather than in the number crunching techniques. The necessity for cost cutting and increased productivity to boost profits puts a great value on the expert (and expensive) knowledge of senior managers, whose tasks have not so far been automated. Expert systems have consequently been widely heralded as an important means of replacing scarce (meaning costly) human expertise.

There has, in recent years, been a great interest in expert systems for management and accounting as reflected both in the number of books and research publications relating to experts systems in the accounting journals and the frequency and attendance at conferences on the issue. Grandiose initial expectations have not been born out in practice and have gradually given way to more modest proposals for narrowly focused expert systems (Ref 1).

The characteristics, uses and applications of expert systems in accounting have been described elsewhere (Refs 2,3). Broadly speaking, the opportunities for introducing such systems depends on the characteristic of the task which include scarce expertise, the necessity for symbolic reasoning or inference based on logic rather than numerical reasoning alone, heuristic techniques (rules of thumb), the inadequacy of existing methods, a knowledge domain that is stable over time, a frequent requirement for this type of decision making, the existence of skilled expertise and the possibility of evaluating the decisions so reached.

Department of Accounting and Finance, University of Manchester,
Manchester, M13 9PL

One area in management accounting which has been seen as an application suitable for an expert system is in analysing variances in financial and production systems (Ref 4). In complex organisations, the source of the more significant variances may be obscured by other variances. An expert system could be used to detect the significant variances for follow up and correction, expecially when thousands of individual variances must be examined to find the few warranting investigation. Thus the essence of the problem is how to decide which of the many variances to examine in detail.

The importance of investigating only material or significant variances is frequently stressed as it is a waste of time and money to examine immaterial or insignificant variances. The problem is how to decide which are significant and worthy of investigation. Some guidelines are suggested in the literature (Refs 5,6). In practice, because variance analysis is time consuming and costly to perform, this important element in the control process is infrequently carried out.

Therefore a system which can derive the necessary variances and then proceed to select those that warrant further investigation has the potential to be an invaluable decision support tool for management. It was decided to build an expert system to do this in order to assess the use of such a system in replacing human expertise and its role as a training device.

DESIGN OF A RULE BASED EXPERT SYSTEM SHELL

A system which would calculate the variances between the expected and actual costs of manufacturing three products, using three different materials (a total of 42 variances) and report which variances were worthy of further investigation was designed and built.

A combination of 5 different approaches was used to arrive at this decision. Firstly, that the variance is less than zero; secondly that it is less than some fixed, predetermined level of significance, eg. the percentage of a suitable measure such as sales; thirdly, that it is more than two standard deviations from the mean; fourthly that it is greater than the average variance multiplied by some factor; and fifthly, that the average variance is greater than a significant level. Thus trends, materiality and tests of statistical significance have all been incorporated into the model. However, cost-benefit analysis and Bayseian methods have not been included.

It was decided to produce a conclusion for each variance rather than just a list of variances that appear to need investigation. There was a choice of three conclusions. First, investigation is advised as long as there are no extenuating circumstances such as a change in standard for that variance. Second, investigation is not advised because the variance is not significant, and third, investigation is not advised because the variance, although significant is too small to be material.

Clearly, the crucial factor was the assignment of probabilities to each rule. These assignments were made on the basis of discussions with 'experts'.

The expert system was designed to run on an IBM pc and uses LOTUS to calculate and print out the variances and produce bar charts of the variances for the previous six periods. The expert system shell EXSYS was used to produce the decisions whether or not to investigate the variances. Data were obtained from a manufacturing company. The system is described more fully elsewhere (Ref 7).

RESULTS

The results obtained from the test data were approximately the same as those of the expert. (Of the 42 variances, 27 did not warrant investigation because they were not significant, 9 were significant but not material and only three were both significant and material, thereby warranting further investigation.) However, that could be expected since the rules were derived in discussion with the expert in relation to these data. It would be useful to evaluate this by using more test data, consulting another expert or by actually using the system in a trial or controlled situation.

This system makes no attempt to discover the causes of the variances or to consider whether the variances are in fact controllable. There is also the problem that after a period of consistently favourable or unfavourable variances that they may be accepted by the system as normal or at least not abnormal. To counteract this, there are rules that attempt to identify this situation. Line graphs of the variances over several periods would bring this out more clearly. Regression coefficients could usefully be included to enable such trends to be detected.

DISCUSSION

There are however more fundamental issues than the design limitations of this particular system which need to be considered, that is the nature of intelligence itself (Refs 8,9). Expert systems are based on rules and yet only a novice, in the process of acquiring a skill, operates on the basis of rules. Through practice, trial and error, the novice becomes more skilled and gradually dispenses with rules. The results are internalised and constitute the pool of experience which will enrich and subsequently supplant the rules. From conscious decision making after reflecting on various options, the novice moves to more automatic decision making.

Experts do not make detached, deliberate and rational selection from several alternatives. They see the situation as a whole, match it unconsciously or intuitively with similar past experiences which they can apply to the present, without having to break it down into its constituent parts. An expert continuously monitors the situation and takes evasive action before the situation becomes irreversible. Expertise is not about making 'one off' decisions, but continuous adjustive action. This is clearly the case in relation to a skill such as driving (Ref 10).

In relation to the five levels of skill outlined by Dreyfus and Dreyfus (Ref 9, op cit.) the decisions of an expert system are at the level of those of a competent performer. This can be illustrated by means of an example. Variances are not discovered out of the blue and then acted upon. A manager who is experienced at his job will have recognised the problem and taken some evasive action long before the variances are calculated.

What then are the advantages and uses of an 'expert system'? An expert regresses to the level of analytical, detached, rule based decisions when the situation is outside his experience; when he has reason to doubt his own expertise. Some external factor may have changes so considerably that the expert has to go back to basics and the rules. In a case such as that, he will be making a competent decision.

'Expert systems' can be used for problems where inferior decisions are still acceptable. In relation to the example used above, it may be a question of using a competent system to make a decision in preference to no decision at all.

If expert systems are, as explained above, proficient or competent systems, then it is potentially very useful as a training device for managers, ie. to give managers, new to a task, repeated practice. Particularly useful features of expert systems shells are the ability to rerun the system using slightly different inputs and secondly the ability to explain how the conclusion was reached.

However, it would be important for students as they became more proficient, to become aware of the consequences of their decisions, both 'right' and 'wrong', as this is how people actually learn, by trial and error. Thus it would be necessary to have a series of exercises which would build upon the decisions made in earlier exercises. Thus an expert system would be only one weapon in an armoury of training tools.

A second use for expert system shells as a training device is that building such a system is in its own right a valuable way of learning the nature of the task as well as the determinants of expertise. This is in itself a useful antedote to the heavy emphasis on rational and analytical reasoning rather than intuitive, holistic reasoning. Students could be set a case study, relating to a decision that has to be made, and asked to work in groups to produce an expert system to perform the task. They should be encouraged to ask the experts, not only for an explanation of the rules, but also the history, philosophy and significance of the decision. The emphasis would be on a comparison and evaluation of the nature of decisions made by human and artificial expertise.

In both cases however, 'expert systems' are only aids in acquiring skills rather than truly expert decision makers. To conclude, the point is that it is only by recognising the differences between the decisions made by an expert and those made by an expert system that we can most effectively exploit the real capabilities of both human and artificial intelligence.

REFERENCES

1. Connell, C., "Expert Systems in Accounting - A Review of Current Applications", paper given at the British Accounting Association, Glasgow, April 1987.

2. O'Leary, D., "Expert Systems in Accounting in a Personal Computer Environment", Georgia Journal of Accounting, Spring 1986.

3. Edwards, A. and Connell, C., "Expert Systems in Accounting: A Preliminary Survey conducted on behalf of the ICAEW", Department of Accounting and Management Science, Southampton University, October 1986.

4. Borthick, A.F. and West, O.D., "Expert Systems - A New Tool for the Professional", Accounting Horizons, Vol. I, No. I, March 1987.

5. Arnold, J.A. and Hope, A.J.B., "Accounting for Management Decisions", Prentice-Hall, London, 1983.

6. Bromwich, M., "Standard Costing for Planning and Control", in Arnold, J.A., Carsberg, B. and Scapens, R.W. (eds.), "Topics in Management Accounting", Philip Allan, 1980.

7. Smith, P.J., "Variance Analysis and Expert Systems", project report for B.Sc. degree in Computer Science and Accounting, Manchester University, 1987.

8. Dreyfus, H. and Dreyfus, S., "Mind Over Machine, the Power of Human Intuition and Expertise in the Era of the Computers", Free Press, New York, 1986.

9. Denning, P.J., "The Science of Computing - will machines ever think?", American Scientist, Vol. 74, July-August 1986.

10. Shaoul, J.E., "The Use of Intermediate Criteria for Assessing the Effectiveness of Accident Counter Measures", Human Factors, Vol. 18, No. 6, pp. 575-586, 1976.

EXPERT SYSTEMS FOR COMPUTER-BASED TRAINING

DORIS KEEFE LIDTKE*

ABSTRACT

Both the relatively recent acquisition of significant numbers of microcomputers and work-stations and the recent successes in applying expert systems in disparate applications areas have generated considerable interest in research and development of better computer-based training/instructional systems[2, 4, 5, 7

]. This paper reports on a project that investigates the feasibility of using expert systems to develop computer-based training systems that conform to the user's learning style, level of expertise desired, and rate of learning. An initial prototype was developed using Hypercard. The prototype includes a friendly user interface and demonstrates the interaction of the user profile with the presentation strategy and the knowledge of the tool to present an appropriate learning episode to the user. Results of the use of the prototype will be reported.

INTRODUCTION

The introduction of advanced software engineering tools requires training for users at widely scattered geographic locations and with significantly different backgrounds both in software engineering expertise and in the depth of knowledge they need about the tools and about their application. This research investigates the possibility of developing user-adaptable, computer-based, automated training to accomplish what would otherwise be an enormous burden for a limited training staff. The automated training would be available on a microcomputer or work-station, would meet the needs of users with diverse backgrounds and a variety of learning styles, and would accomodate the training to the differing skill levels of the trainees.

Though the field of intelligent, computer-based training/learning is still in its infancy, there seems to be agreement among researchers that Intelligent Computer-Assisted Instruction (ICAI) systems or Intelligent Tutoring Systems (ITS) should be composed of several major modules and that these modules can and have been implemented, albeit independently. Though the names of the modules vary from researcher to researcher. However, the agreed upon functions they provide are: 1) a user interface, 2) a model of the user, 3) knowledge of the domain, and 4) knowledge about teaching or presentation strategies.

An initial prototype of a simple domain was developed. This prototype will be revised, expanded and tested against a traditional training system.

BACKGROUND

Though there has been an interest in using computers in education and trainingsince the earliest days of computing, only in the last few years have computers been widely available. Though computers have and are being used in schools to support drill and practice, computer literacy and computer programming, there are virtually no ICAI systems in the classrooms. In government and industrial training, the situation has not been markedly different, except for the use of sophisticated, computer-based, training simulators. The reasons for the general paucity of ICAI systems include: 1) ICAI programs generally require a computer system that is more powerful and sophisticated than a microcomputer, 2) the level of understanding about how people learn is still rather primitive, 3) the level of understanding of the instructional process is still more of an art than a science, 4) understanding of "conversation" between human and machine is at an

---

*Software Productivity Consortium, 1880 Campus Commons Drive, North, Reston, VA 22091 while on leave from Towson State University, Baltimore, MD 21204

elementary level, and 5) representation of domain knowledge is difficult and time consuming. In spite of these problems, there is much recent interest in ICAI systems and some research endeavors have produced systems that are of sufficient quality to warrant the additional investment in the development of ICAI systems [2]. Furthermore, expert system shells have proved their value in business and industry and show great promise of being of assistance in developing ICAI systems. While current ICAI systems are the product of the research environment, the essential elements of an ICAI system have been demonstrated as individual elements in recent research projects and these projects contain the foundation upon which to build [2, 6]. The literature makes it clear that using expert systems in developing user adaptable, automated training is a non-trivial undertaking [2, 5, 7]. However, research supports the idea that ICAI systems, though costly, are now realizable, that the returns may be great, and that successful ICAI systems may serve as templates for additional ICAI systems. Many of the projects recently funded by the Advanced Technologies Program of the Science and Engineering Education Division of the National Science Foundation propose to develop ICAI systems.

ELEMENTS OF AN ICAI SYSTEM

For an automated, intelligent teaching/training system to be effective it must have the following conceptual elements, whether they are seperate entities or not: 1) user interface, 2) knowledge of the domain, 3) knowledge about the transfer of knowledge, and 4) a model of the user. These entities must interact to carry out the knowledge transfer process. In an ICAI system the user interface communicates [5] between the computer and the user.

> Effective communication does not mean natural-language understanding or generation; natural-language processing has been achieved to some degree. Rather, effective communication requires looking beyond the words that are spoken and determining what the tutor and student should be communicating about. ... [GUIDON] carries on a flexible dialog with the student because it uses inference techniques to 'tease apart' the student's knowledge. It also selects which dialog is most appropriate to use in a given situation and makes the selection based on the tutor's inferences about the previous interactions and the student's current information. [7, p 65]

The **knowledge about the domain** contains the facts and rules about the subject under study. When the system presents problems to the student to solve, the system should be able to reason about the solution to the problem, or to reason with the user to determine if the users' solution is correct or incorrect. The domain knowledge "allows the tutor to articulate the structure, underlying causal mechanisms, and strategies of the domain." [2, p. 2]

The knowledge about the transfer of knowledge, **presentation strategy**, is important to allow for adaptation by the system to the diverse needs and preferred style of learning of the user. Typically the transfer of knowledge involves one or more of the following activities: assessment of current user knowledge, presentation of new material, questioning about the understanding of some concept or fact, explaination of some facet of the material, presentation of a problem to be solved, presentation of an example, answering a question, summarizing or drawing conclusions. Combinations of these actions are used to make up a "learning episode."

The **model of the user** is essential for containing a record of the current knowledge of the user, the level of knowledge desired by the user, past interactions of the user with the system, and from this the preferred learning style of the user is ascertained. This knowledge of the user is essential for the planning of "learning episodes." Simple models may simply map the user knowledge, while more sophisticated models may assess the current understanding and misunderstandings to determine the appropriate concepts, facts or goals to pursue with the user.

In addition to these major elements of an ICAI system, there must be some method of evaluating user responses. This could be a separate module or could be a part of one of the other modules. In any case, the knowledge about the domain and reasoning about that knowledge is used to evaluate the user response. Based upon the presentation strategy and the acceptability of the user response, the model of the user may be modified, the learning episode may be modified, the learning episode may continue or some combination of these actions may occur.

PROTOTYPE

The initial prototype was developed using Hypercard. The four modules of the prototype include 1) a user interface, 2) a model of the user, 3) a knowledge base about Buhr Diagrams, and 4) a presentation strategy. Since the Software Productivity Consortium will have a standard user interface for its products, a simple, easy-to-use interface was all that was needed for the prototype. The user interface provided by Hypercard is menu-driven, easy-to-use and is adequate for this prototype. While this interface does not provide for a multi-windowed screen presentation which would allow the prototype to show simultaneous use of the automated training system and of the tool on which the user is being trained, Hypercard was chosen because of its ready availability and other features which support rapid prototyping.

The simplified user model obtains the initial user characteristics by requesting the user to indicate whether they 1) are a fast or slow learner, 2) desire a thorough understanding of the tool or an overview, and 3) prefer to learn about the tool through tutoring, examples or browsing. [Only the tutoring "thread" of presentation is developed with a few samples that demonstrate examples, questioning and the implementation of some hypertext capabilities.] The simplified user model contains a map of the knowledge base for tagging facts and rules that are known by the user and areas in which the user has demonstrated misconceptions.

The prototype of the knowledge base can be viewed as a multiply-linked nodes which contain the knowledge to be presented to the user. A first level of this linkage reflects the heirarchy of the concepts to be presented and the order in which the knowledge should be presented. This can be used to determine if the user has the prerequisite knowledge, and provides pointers to the "granules" of knowledge to be presented. This also allows for use of the knowledge base to present deeper knowledge, to summarize or to present an overview.

The first presentation strategy to be implemented is tutoring. At least one more strategy will be implemented, with more as time permits. The strategy may be determined after each user response, but in many instances a series of "granules" of knowledge are presented as a "learning episode" and only at the end of the "learning episode" will the strategy be determined for the next "learning episode." Each user response will be recorded and may be used to determine future interactions with the user and to update the model of the user knowledge. The "learning episode" is determined by the user characteristics and the knowledge base. First the next fact or concept to be presented is determined by comparison of the user knowledge and the knowledge base. Then the manner in which this will be presented is determined by the user characteristics.

Besides the elements described above, the prototype provides the user with the ability to override the presentation strategy. At any time the user may decide to: 1) see an example, 2) browse, 3) ask for the definition of a term or concept, 4) move to another portion of the training, 6) be questioned on the material, or 5) terminate the session. Careful monitoring of the frequency and manner in which this facility is used should give additional guidance in developing more appropriate "learning episodes.

VALIDATION

The prototype will be revised and tested to determine whether users attain the same level of facility in the use of the tool with automated computer-based training as when they are trained in the traditional manner, which uses hardcopy materials and live presentations supported by viewgraphs, slides and videotape demonstrations of the use of the tool. The sample group for the study will be software engineers with various levels of expertise from a number of different member-companies of the Software Productivity Consortium.

Many other aspects will need to be considered before recommendations can be made regarding automated, computer-based training in a software engineering environment. Among these aspects are costs of development and system maintenance, number of users requiring training, user reaction to the system, and the longevity of the tool.

CONCLUSIONS

Recent research in the fields of artificial intelligence, cognitive psychology and knowledge transfer provide a basis upon which to begin to build ICAI systems. Etienne Wenger states, " ... that intelligent tutoring systems remain difficult to build. The most successful projects ... have required years of work by talented people, and have often gone through several generations of prototype systems involving major reconsiderations of approach. Few of these systems have left the laboratory. These comments are not pessimistic. Teaching is difficult, and the fact that designing intelligent tutoring systems requires such a deep understanding of the processes involved may well be a sign that we have found a methodology whereby we can start attacking general issues in a systematic way." [5, p. 8]

BIBLIOGRAPHY

[1] Buhr, R. J. A., (1984) **System Design with Ada**, Prentice Hall, Englewood Cliffs, NJ.

[2] Clancy, W. J., (1987), **Knowledge-Based Tutoring: The GUIDON Program**, The MIT Press, Cambridge, MA.

[3] Kearsley, G. P., (1987) **Artificial Intelligence & Instruction: Applications and Methods**, Addison Wesley, Reading, MA.

[4] Sleeman, D. and Brown, J. S. (eds), (1982) **Intelligent Tutoring Systems**, Academic Press, London.

[5] Wenger, Etienne, (1987) **Artificial Intelligence and Tutoring Systems: Computational and Cognitive Approaches to the Communication of Knowledge**, Morgan Kaufmann Publishers, Los Altos, CA.

[6] Woolf, B. and Cunningham, P. A., (1987) "Multiple Knowledge Sources in Intelligent Teaching Systems," **IEEE Expert**, July, pp. 41-54.

[7] Woolf, B. and McDonald, D., (1984), "Building a Computer Tutor: Design Issues," **Computer**, September, pp. 61-73.

CLASSROOM IMPLEMENTATION of ADVANCED PERSONAL BASED COURSEWARE AUTHORING TECHNIQUES

E.D.DOAK*, H.L.MARTIN+

ABSTRACT

A joint demonstration for the implementation of personal computer based courseware is being conducted by the University of Tennessee, the Oak Ridge (Tennessee) School system, TeleRobotics International, Inc., and Apple Computer, Inc. University education majors are developing curriculum specific courseware for implementation in a local middle school. The objective of the effort is to demonstrate the feasibility of using inexpensive development and delivery systems with user-friendly authoring tools to create quality courseware without requiring the assistance of programmers. Simultaneously, the performance of students will be monitored to determine the affects this technology has on the educational process and will actually use the authoring system to complete assignments and to create courseware for each other.

INTRODUCTION

Through hardware donations from Apple Computer, Inc. (25 Macintosh computers and associated peripherals) and software authoring systems from TeleRobotics International, Inc. (Course Builder authoring system), a unique joint demonstration program between the University of Tennessee and the Oak Ridge Schools has been initiated. With user friendly personal computer based authoring tools and delivery systems now becoming available, the ability of a single educator to create courseware or electronic textbooks is becoming a reality. The purpose of this project is to demonstrate that education majors with no formal computer training can learn to develop useful courseware and that this courseware can have a positive affect on the performance of elementary school students.

With reductions in hardware costs and availability of visual programming techniques that convert storyboard flowcharts into computer code, the field of computer aided instruction may be coming of age. This project explores the technology and its affect on students in an attempt to better understand the needs of both the teacher and the classroom with respect to the application of large quantities of computers and courseware in junior high curriculua.

COMPUTER AIDED INSTRUCTIONAL DESIGN

Educators must learn to make application of computers toward enhancement of the educational process. Without question, students can and do learn much through computer assisted instruction. The age old problem of bringing instructional design and computer programming together remains. Educators know instructional design and curriculum; computer programmers know the language of computers. It is the authors' contention that educators generally will not learn a formal programming language at least to the point of competent efficient use for writing CAI programs. Neither are computer specialists likely to become instruction/curriculum experts. Thus the rationale for development of an authoring language which enables the educator to write quality educational software.

For the past three years undergraduate education students at the University of Tennessee have taken a course entitled "Computer Assisted Instruction: Software Evaluation and Design".

---

*University of Tennessee, College of Education, Knoxville 37996

+TeleRobotics International, Inc., Knoxville, TN 37931

The course has focused on the production of tutorial software using the Apple II and Super Pilot. While the course has met with great success and computer entry level students have produced good tutorial programs (even excellent in many cases) the use of other techniques than text material (i.e. graphics, animation, & voice) in the program design has been difficult at best.

The current project tests the efficacy of Course Builder and the Macintosh computer in producing quality software. The students are first-time acquaintances of computers. They are designing programs for a sixth grade class in the Oak Ridge Schools. The teacher of the sixth grade class designates the lesson topics, participates with the college student in field testing the program(s) and will utilize the programs in correlation with other instructional formats. The unique features of the arrangement include:

. undergraduate students learn while designing "real" lessons
. these lessons undergo field testing and revision
. the sixth grade teacher has "curriculum personalized" CAI lessons for enrichment, remediation, drill and practice and a regular tutorial level work.

Instructional design includes fundamental principles such as:

.checking and enhancing prerequisite knowledge
.presenting the organizing structure early in the lesson
.initial activities designed to captivate student interest
.questioning strategies aimed at eliciting a variety of student thinking and problem solving
.inactive, iconic and symbolic modes of representation of ideas
.frequent substantive feedback with branching for reteaching or acceleration
.learner programmatic control throughout each program
.definite closure activities for each lesson or major portion.

University students in this course learn both instructional design and the computer skills necessary to utilize the authoring tools to develop good computer assisted lessons, personalized for a particular group of students

A COOPERATIVE DEMONSTRATION PROGRAM

The courseware developed in the University of Tennessee classes described above will be utilized in the sixth grade classes at Jefferson High School. The actual texts, enrichment materials, and course outlines used in mathematics, creative writing, and science are being utilized by the UT Education majors to develop their courseware projects. The program will be implemented at Jefferson during 1988-89 school year beginning in August. Standardized testing data is being correlated for all of the student participants and their progress will be measured with test data at the end of the year.

Special curriculum based pre-tests and post-tests will also be administered to the test group and a controlled group to determine the learning retention affects of the technology.

The authoring tool, Course Builder, will be taught to the sixth grade students and many of their assignments will utilize this media for creating reports for their fellow students. The result will be large quantities of generated courseware, some of which will be useful in future classes. It has often been said that the best way to learn a subject is to teach it. By creating dynamic courseware using their individual creativity, it is envisioned that the learning process will be greatly enhanced.

A VISUAL COMPUTER ASSISTED INSTRUCTION LANGUAGE

A short analogy explains the logic behind visual programming. While illiterate adults cannot break the code of written language, few have difficulty expressing their needs in spoken words or in sketches. Apply the same parallel to computer programming. There is a world filled with intelligent teachers that are capable to expressing useful ideas, but few have been trained to break the code of computer programming. If the barriers to courseware development are lowered (those barriers being the effort expended to learn to communicate with the computer and the cost invested in gaining access to one), then the amount of available courseware should significantly increase.

Course Builder utilizes fundamental blocks to allow a flow diagram of course material to be drawn. The categories of blocks consist of output, input, flow , and nesting. Using this simple set of blocks, material can be presented, questions posed, answers evaluated, and responsive sequences presented. Within each block, Course Builder provides the tools needed to construct or evaluate the situation at that point. Figure 1 shows part of an example course flowchart developed with Course Builder. The small blocks arranged vertically on the left side of the "Course Map" allow the various blocks to be designated and created. The lines between blocks represent the flow that occurs during the course. The flowchart actually writes the code necessary to run the course. The courseware creator is not required to have any further understanding of the inner workings of the computer.

Within each block, an environment is provided for preparing graphical and text presentations (output blocks), soliciting student information (input blocks), or organizing content (nest blacks and flow blocks). Figure 2 gives an example of the environment provided for outputs. The tools shown in Figure 2 allow graphics and text to be displayed in any desired manner. Additional features include speech synthesis, digitized sound, animation, automatic student report generation, and intelligent branching based on student performance. The course can be run at any time and starting from any block so testing the performance of the course is very straightforward. The resulting courses can be saved as self-running applications and copied for distribution to large numbers of students. With the flexible block diagram approach and the ease of use of the environment, Course Builder opens new opportunities for courseware generation and computer education.

SUMMARY

A joint demonstration for implementation of personal computer based courseware has been described. The project began January of 1988 and will continue through June of 1989. As of this date, the first group of Education majors have been exposed to the technology and have generated their first courseware using the authoring language Course Builder. Future papers will detail the results of the efforts both from the usefulness of this project in introducing future teachers to courseware potentials and impact on students performance.

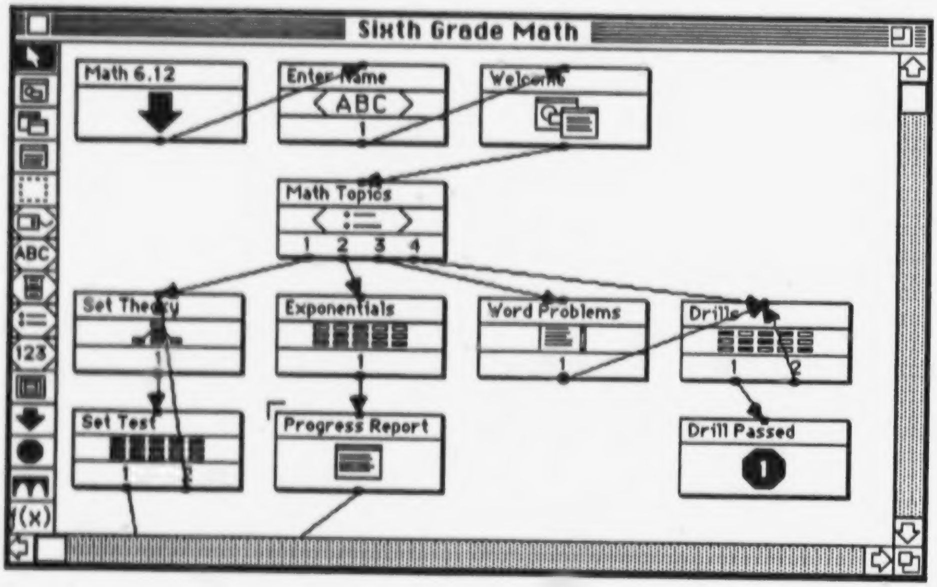
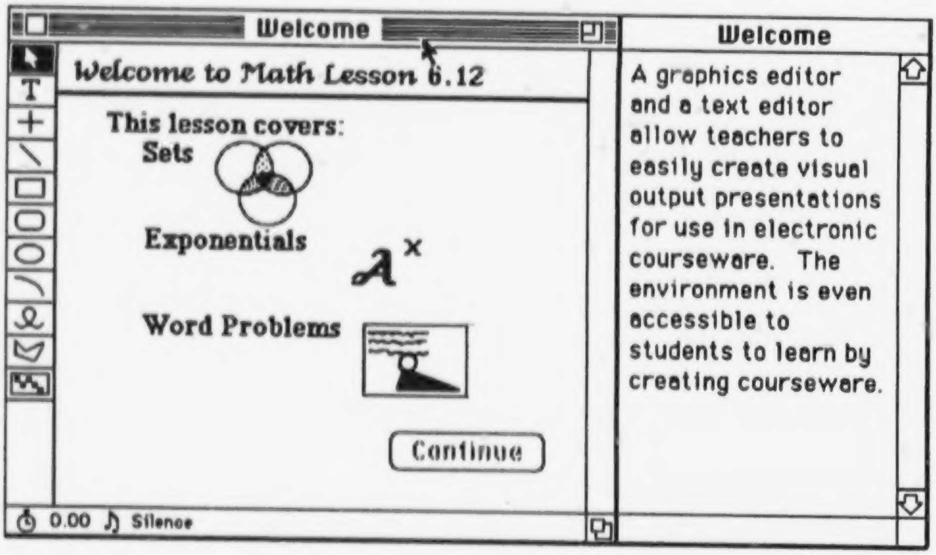

Sixth Grade Math
Math 6.12
Enter Name
ABC
1
Welcome
Math Topics
1 2 3 4
Set Theory
1
Exponentials
1
Word Problems
1
Drills
1 2
Set Test
1 2
Progress Report
Drill Passed
1
ABC
123
f(x)

Figure 1 - Course flow diagram created with Course Builder.


Welcome

Welcome to Math Lesson 6.12

This lesson covers:

Sets

Exponentials

Word Problems

Welcome

A graphics editor and a text editor allow teachers to easily create visual output presentations for use in electronic courseware. The environment is even accessible to students to learn by creating courseware.

A^x
Continue
0.00
Silence
T

Figure 2 - Environment for creating graphical and text outputs for courseware generation.

MAXIMIZING LEARNING - BY DOING: TEACHERS AUTHOR CAI PROGRAMS FOR THEIR STUDENTS

Dorothy H. Judd† and Robert C. Judd*

ABSTRACT

Training teachers in computer literacy is not enough. Hands-on experience with microcomputers and appropriate software results in better integration of computer assisted learning in the curriculum. Helping inservice teachers learn how to create CAI lessons using the PILOT language brings about the preparation of more lessons than using BASIC. For the past three years a public domain authoring language program, created by a Canadian professor, has been used successfully by teachers taking a graduate course at Southeastern Louisiana University. This program, by Dr. Michael R. Smith of the University of Calgary, provides an automatic translation of the PILOT authored program into BASIC, thus permitting use of the lesson on any Apple or compatible microcomputer without the need for a special access disk. The presentation will feature examples selected from among teacher-created lessons for elementary and secondary students in mathematics, language arts, physical sciences, computer literacy, and business education subjects.

INTRODUCTION

PILOT is a productivity tool used by teachers to prepare lessons that can provide effective computer assisted learning. Individualized computer learning opportunities can be prepared because teachers have a thorough knowledge of the curriculum and the needs of their students. These CAI lessons on diskettes can be used any number of times on an Apple or compatible microcomputer as opposed to the costs of time and money in repeated preparation of a worksheet, stencil, ditto master, or other paper and pencil assignment. The public domain PILOT language represents a minimum cost in both money and teacher time, and gives teachers the opportunity to create CAI lessons more easily that fit student and curricular needs. Of course teachers may create computer-assisted lessons by using commercial authoring systems and authoring languages, or by using programming languages such as BASIC and Pascal. However, authoring systems and languages are often costly in money while BASIC and Pascal programming are costly in teacher time.

Teachers turn to PILOT when they cannot find or afford commercial courseware that is appropriate for their students and their curriculum. A cost-effective solution is the public domain authoring version of PILOT. These five letters stand for Programmed Inquiry Learning or Teaching. The original program of that name was created for the mainframe by John Starkweather, a doctor at the University of California

†Assistant Professor of Education, Southeastern Louisiana University, Hammond, LA, 70402 USA, *Professor of Management Southeastern Louisiana University, Hammond, LA, 70402, USA

Medical School, in the early 50's. The documentation included in this paper is for the PILOT version created by Michael R. Smith of the University of Calgary in Canada.

Examples of some programs written in PILOT and run in BASIC will be shown in the conference presentation. These programs are as diverse as lessons in mathematics, language arts, physical sciences, computer literacy, and business education subjects. The Louisiana teachers who wrote these lessons began by reviewing learning theories and instructional strategies that apply to creating CAI lessons in general. Then they began to design a lesson of their own choosing. The contrast in time demands between programming in BASIC and PILOT is evident by comparing the two command vocabularies given below. PILOT calls for twenty percent or less keyboard work than BASIC to accomplish the same result. For teachers who already know BASIC, the saving in time comes as a pleasant surprise. In those rare instances where the Smith version of PILOT cannot provide the desired learning experience for students, the shift to programming in BASIC for specific commands is as quickly accomplished as substituting the B: command for a PILOT letter command.

STEP-BY-STEP

The first step in creating a lesson is to think through the purpose which leads to determining the specific objective or objectives of a lesson. Since teachers have taught the lesson a number of times previously, they are familiar with the sequence of the teaching/learning events. Next, teachers make a series of screen layouts or storyboard that will insure the program provides the instruction, as well as appropriate questions, feedback, and the acceptable answers. At this point teachers are ready to enter the lines of code for their PILOT lesson. The key elements in using the Smith version of PILOT are:

1. loading the PILOT authoring program;
2. entering lines of code;
3. editing the lines of code for desired changes;
4. converting from PILOT to BASIC automatically;
5. running the completed BASIC program to evaluate its congruence with the teaching/learning goals.

The two screens of significance to the teacher/programmer are EDITOR REQUEST and EDIT COMMAND. The EDITOR REQUEST screen presents action choices. The choices and their meanings are given below (the following list can be accessed online by pressing shift-H and RETURN).

A)lter the name of the program now in memory.
C)atalog request for program names on the disk.
E)dit the program now in memory.
LI)st the program in memory on the screen.
LO)ad the program desired into memory.
M)ake the conversion from PILOT to BASIC language.
N)ew - must be used when coding a new lesson.

P)rint the program in memory on a printer.
Q)uit the PILOT Editor program.
RA)te - slow down the rate at which the code LIsting scrolls on the screen.
RE)place the PILOT lesson that is presently saved on the disk with the revised version.
S)ave the program in RAM to disk.
T)est the programming syntax of the PILOT version that has been created to check for correctness.

The EDIT COMMANDS screen presents editing choices. The choices and their meanings are given below (the following list can be accessed on-line by pressing shift H-RETURN).

A)dd .a line or lines of code for the lesson
C)hange.a line(s)   D)elete.a line(s)
I)nsert.a line(s)   LI)st...onto the screen
P)rint..to a printer   Q)uit...return to main menu
RA)te...adjust listing speed   S)ave...the program

The actual PILOT PROGRAMMING COMMANDS are listed below together with their meanings (the following list can be accessed on-line by pressing CONTROL-P).

A: accept student answer.
B: shifts the program to using BASIC as a language.
E: signals the end of a program.
G: used to invoke a graphic mode.
J: jump from where given as a command to the place in the program indicated by the label used.
L: used to link the present program to one that should be automatically viewed next.
M: match student response with the correct response.
R: remark - not shown to student but useful to teacher as information or a reminder of what was to be accomplished at a given point in a program.
T: indicates wanting to type something in the way of a question or statement. Can also be used without any text to provide spacing for better readability.
U: "use" - as a way to branch to a small, sub-part of program and return to the next command from the point where the program branched to the sub-routine.
X: used to check on whether a BASIC statement is "true" - whether the BASIC condition laid down in the BASIC code lines has been met.
*: indicates the start of a lesson section.

Other useful commands are:

Y (N) answer that triggers the program to do something if the match is either right (or wrong). Often it appears in the form of TY: or TN:
TC: clears the screen and then presents the material typed after this command.
TH: causes the material typed following this command to be presented on a single line. Useful in keeping the response on the same line as the question.

TI: causes whatever is typed following this command to be shown as highlighted or inverse print.
TV: causes whatever is typed to be presented the specified number of lines down from the top of the screen.

LINE EDITING COMMANDS are listed below (and can be accessed on-line by pressing CONTROL-A).

Control-A..Help
Control-B..Move cursor to start of line
Control-D..Delete at cursor position
Control-F..Find the next character typed in
Control-I..Insert at cursor position
Control-N..Move cursor to end of line
Control-P..Displays PILOT commands
Control-Q..Delete line after cursor
Control-R..Recover version of line before deletion
Control-X..Delete the line
<CR>   Keep the line as it stands
<- AND -> Move the cursor

PILOT commands and their BASIC language equivalents are:

PILOT	BASIC
T:	PRINT
A:	INPUT
A:$N1$	INPUT N1$
M:	IF/THEN
_Y:	GOTO
_N:	GOTO
TI:	INVERSE
TC:	HOME
TV:	VTAB
R:	REM
U:	GOSUB
E: at end of U: routine	RETURN
L:	CHR$( )
J:	GOTO
X:	LET
E:	END

CONCLUSION

In this paper, learning by doing refers to dual outcomes. Not only do teachers learn to create their own CAI lessons using the Smith version of PILOT, but students also learn by responding to these teacher created lessons. That is maximizing learning! Just because the Smith version costs no more than the price of a blank disk does not mean that the program is worth as little as it costs. Experience demonstrates that the time invested in learning to use Smith PILOT is almost as economical as its price.

COMPUTER-CONTROLLED VIDEO IN TEACHER TRAINING

Laurence D. Brown and David H. Gliessman*

ABSTRACT

Computer-controlled video has made possible the achievement of interpretive skill in teacher training. Interpretive skill, in turn, is the basis of performance skill. The Indiana project has focused on the development of skill in interpreting teacher explanations in terms of clarity. The assumption is that gains in such skill will lead to greater clarity of explanation. Two forms of computer-controlled video, learner-based and instructor-based, can be used to develop interpretive skill.

This paper describes how a new technology has made possible the achievement of a key objective in a professional field of study. The technology is computer-controlled video, the professional field teacher education and the objective, interpretive skill. We will first present a rationale for interpretive learning in terms of the concepts relevant to our own project and then describe two forms of technology utilization designed to contribute to interpretive learning.

The focus of the Indiana project is clarity of explanation. Our work on this concept draws upon two lines of research that relate teaching skill to pupil learning: research on explanation as conducted by Brown (ref 1) and Brown and Armstrong (ref 2) and the extensive work on clarity in teaching most recently reflected in the work of Cruickshank and others (ref 4). From Brown are taken the categories of explanatory types, descriptive, interpretive, and reason-giving. From Brown and Cruickshank are taken six components of clear explanation: keys, links, framing, focusing, exemplification, and monitoring understanding. According to this body of research clear explanation results when a teacher, knowing the type of explanation intended, sets the context (frames), presents the main ideas (keys), highlights them (focuses), ties them together (links), gives various illustrations (exemplifies), and continuously checks for effects on the learners (monitors understanding). These characteristics or categories may be thought of as concepts that may be used to classify specific behaviors within teaching episodes.

The generally accepted criteria for concept learning include successful identification of concept instances plus supplying acceptable definitions and listing critical attributes. In the context of this paper, acquisition of the concepts of clear explanation would include learning the meanings of keys, links, framing, etc., and identifying instances of these concepts as well as listing critical features.

Definition, attribute listing and identification cannot, however, be viewed as the most fundamental learning criteria. As the primary criterion for learning we would argue for the "interpretive use of concepts." For clarity related concepts to be used in an interpretive sense, one should be able to abstract them from complex episodes of explanation and to use them singly and collectively to analyze, interpret and assess the clarity of an explanation. In an earlier paper (ref 3) we attempted to make the case that teaching is essentially based in

*Indiana University, Bloomington, USA

interpretation:

> "...Any deliberate act of teaching derives from an interpretation by the teacher of pupil behavior or of his own behavior. This is another way of saying that the act of teaching is conceptual, that it is moored in concepts about what is being taught and for what purpose. This proposition leads to a further one: skillful teaching is based in skillful interpretation. That is, the timely use of an appropriate skill derives from a perceptive interpretation of behaviors and events."

Significant evidence comes from the work of Doyle (ref 5) who differentiated successful teachers as those who could "chunk" events within the classroom into relatively few, but highly practical, categories. We would argue that the concepts of clear explanation constitute the "chunks" into which one can sort events of practical significance. An added advantage is that if concepts such as these can be acquired during training, teachers need not be required to learn them inductively, or intuitively, through direct experience.

A second problem involves the peculiarity of the concepts which constitute the components of clarity. While the literature on concept formation and concept learning is extensive, the range of concepts used in that research is quite limited. Much involves artificial concepts, and that which involves real ones seems to make the greatest use of class nouns having concrete referents and clear boundaries. The concepts of clarity are imbedded in complex events. They are largely behavioral and have varying features. Focusing as a concept, for example, refers to what a teacher does to give emphasis to some aspect of an explanation, probably a key. She could write it on the board, change her voice to give stress, tell the students to make a note, or make use of a variety of nonverbal behaviors to communicate significance. To instance this concept in a manner which would serve an interpretive objective would require confronting the learner with something as close to the real event as possible with emphasis on variety and individual styles. Written descriptions of the events would not suffice, nor would transcripts or still photographs. Live observation, while the most real, precludes interpretive feedback, and is inefficient in terms of the number of relevant concept instances which might occur during an observation. The answer must be filmed or taped episodes, edited or programmed for efficient sequencing of relevant scenes, in which learners are asked to identify instances followed by feedback on the accuracy of their identifications.

To develop interpretive skill and then to hypothesize that teaching is based in interpretation, however, leaves open the nature of the relationship between interpretive skills and performance skills. How are interpretation and performance connected in teaching? One can assume that the concepts that make up the act of interpretation mediate between classroom events and teaching behaviors. A teacher may be said to "read" events in the classroom in terms of specified concepts that then cue or suggest appropriate behaviors or actions. For example, a perceived lack of understanding on the part of his students may be interpreted by the teacher as resulting from a failure to clearly link several key ideas which, in turn, suggests the need for clearly stating the connecting links.

There are two lines of evidence supporting the presumed relationship between concepts used interpretively and as mediators of behavior. The first of these comes from the observational and introspective study of teaching. Evidence by Doyle (ref 5) has been cited suggesting that successful teachers categorize classroom behavior in a more practical way than do less successful teachers. Since the criterion of "success" was smoothness of classroom functioning, it may be assumed that this difference in categorization was reflected in more effective management behaviors. Verloop (ref 8) has shown that teacher trainees who received instruction in the elements of a teaching strategy supported by videotaped examples (1) reported thinking more often about those elements while teaching and (2) demonstrated those elements in teaching more often than did trainees who received instruction without the support of examples. In both of these studies, concepts about teaching can be viewed as mediating teaching behaviors.

The second line of evidence supporting the mediating function of concepts can be found in studies that have assessed the relationship between concept mastery and use of the referent skill in teaching. One would predict, if the mediating hypothesis is correct, a significant positive relationship between the above two variables. In three studies that have assessed the relationship, a significant correlation was reported between level of acquisition of a questioning concept and frequency of using the referent questioning skill in teaching (ref 6).

In spite of substantial evidence of the effectiveness of interpretive training on teaching skill, one should not assume that training directed at the acquisition of clarity-related or other kinds of skills will assure the use of these skills in the classroom. How can one increase the probability that skills acquired in training will be used in the classroom? In terms of the rationale of this paper, the question might better be phrased: How can one increase the likelihood that the appropriate concepts will be retrieved by the trainee during teaching? Here one can profitably think in terms of metacognition as a variable. Metacognition refers to the kind of explicit awareness of one's own cognitive processes that eventuates in surer control of those processes. While one can assume that the ability to use concepts interpretively will result from simulated experience, assuring that these concepts will be at a high level of availability during teaching requires concrete experience at a more complex level. Observing "live" teaching, preparing an actual explanation and presenting that explanation to an actual group or class, all with highly conscious use of the clarity-related concepts that have been identified, provide the kind of concrete experience that would appear to be basic to increasing the availability of concepts.

The title of this paper uses the term "Computer-Controlled Video", specifically avoiding "Interactive Video." The meaning of "interactive video" is restricted too much to computer-assisted instruction (CAI) with video attached. It seems to imply an individual learner seated at a terminal. The interaction implied applies as much to the interaction of components of the system as it does to that between the learner and the system. In addition the term continues to suggest a supplement to the conventional classroom or a substitute for it rather than an integral part of it. Our preference is to conceive of a system which admits a range of usage from an individual-based system to an instructor-based system usable with small groups or entire classes.

Consider two kinds of elements in a computer-controlled video system to train preservice teachers in clarity of explanation, technical and instructional. Technical elements include component hardware which enables component interaction, and the programs which carry out the interaction. The instructional elements in this case include (1) multiple scenes of complete explanations, (2) multiple scenes which exemplify each of various subconcepts of clarity of explanation, (3) scenes which gradually involve various combinations of the subconcepts, (4) text which provides background information, definitions, and interrelationships among the various subconcepts and (5) interpretations of every scene which tie events in the scenes to concept meanings. These elements seem essential for either individual or instructor based systems.

To these elements for the individual system would need to be programmed the questions posed to the learner, the response contingencies, record functions and whatever additional ingredients are needed to make the program self-sufficient. For the instructor-based system the same five instructional elements are needed but the additional features are either unnecessary or, if included, provision is made to allow the instructor to override the program. For in the instructor-based situation, program sequence is less predictable and access by the instructor to whatever scene, interpretation, or conceptual information is required by class needs is essential. An open question at this point is whether separate programs would be better than a single program with override possibilities built in. A consideration is the number of intermediate possibilities for system utilization which lie between individual and instructor-based forms. Actual adoption in teacher education programs may depend on adaptability to local circumstances and the preferences and prejudices of individual instructors.

REFERENCES

1. G Brown, Lecturing and Explaining (Methuen, NY, 1978)
2. G Brown and S Armstrong, Explaining and Explanations in E Wragg, Classroom Teaching Skills (Croon Helm, London, 1984)
3. L Brown and D Gliessman, The Role of Interactive Video in the Acquisition of Teaching Skills in E Doak, T Hipple and M Keith, Simulation and Clinical Knowledge in Teacher Education (Univ of Tennessee, Knoxville, 1987)
4. D Cruickshank and J Kennedy, Teaching and Teacher Educ, 20, 43-67 (1986)
5. W Doyle, Journ of Educ Res, 28, 51-55 (1977)
6. D Gliessman and R Pugh, Int Journ of Educ Res, 11(5), 41-49 (1987)
7. J Kennedy, D Cruickshank, A Bush and B Myers, Journ of Educ Res, 72, 3-10 (1978)
8. N Verloop, The Effects of Video Materials on Student-Teachers' Cognitions During Their Interactive Teaching, AERA Paper (1984)

The Effectiveness of Computer-based Instruction: A Review and Synthesis of Research from 1980-1987

M. D. Roblyer*

ABSTRACT

Research results have rarely been used to direct the course of computer use in education or to justify the enormous expenditure of funds for microcomputers in the last decade. However, the costs of maintaining and expanding the instructional computing movement in the U. S. makes a review of past results a more urgent matter. This paper reports the results of a recent comprehensive review of research in the field of instructional computing. A meta-analysis procedure is described which was used to summarize the results of some 38 studies and 44 dissertations in all content areas reported from 1980 to 1987. Effects on achievement and attitudes are reported for mathematics, reading/language, and cognitive skills, as well as for specific applications within these areas such as word processing and Logo use. Results of the review are discussed in terms of their implications for future emphases in both research and school practice.

INTRODUCTION

If the hundreds of articles written since 1980 are any indication, classroom instruction has changed dramatically as a result of microcomputer applications for instruction. The literature is rich with claims of unique effects for various computer-based methods and products, and some authors maintain that the new kinds of learning made possible by computer applications are actually changing the goals of education.

However, society currently has some very specific measures for the effectiveness of its educational system: student achievement, attitudes, learning time, drop-out rate. After some 20 years of use in instruction, the impact of computer applications on these measures remains largely an unknown quantity. Part of the reason for this is that decision-makers have rarely depended upon research results to address issues of educational effectiveness. Up to now, lack of effectiveness data has not curbed educators' enthusiasm for microcomputers. But as educators call for more extensive, equitable use of microcomputers and replacement of outdated technology, those who must fund these resources have urgent questions about the usefulness of this technology in classrooms. The purpose of this review is to provide some tentative answers to some of these questions based on the findings of recent research.

REVIEW METHODS

Past reviews, even the most recently-published meta-analyses, have concentrated primarily on computer studies prior to 1980. Since the focus of this review was on microcomputer applications, an intensive search was undertaken for studies from 1980 to the present which contained data suitable for including in a meta-analysis. A DIALOG search was supplemented by reviews of individual issues of journals known to contain research articles on instructional computing, and by contacts with professionals in the field. This search yielded a total of 38 articles, papers, and reports and 44 dissertations during the eight-year time period.

Data from these studies were analyzed in the following ways:

1) *Calculation of study effect sizes* - An effect size (d) was calculated on each measure and group reported in the study. This statistic is found by subtracting the mean score of the control group from that of the experimental (computer) group, and dividing the total

---

*Panhandle Center of Excellence, Florida A&M University, College of Education, Tallahassee, Florida 32307 (Area Code 904-599-3289)

by a pooled standard deviation. This procedure is usually shown by the following general formula:

$$\frac{\bar{X}_T - \bar{X}_C}{SD_P}$$

Since the number of subjects included in a study is one factor which causes effect sizes to vary, a statistical procedure was used to correct each *d* for sample size.

2) Calculation of group effect sizes - Effect sizes were calculated across categories (such as elementary studies or mathematics studies) by combining effect sizes of individual studies. This overall *d* was again corrected for sample size.

3) Test of homogeneity - A statistical procedure was used to determine whether or not effect sizes of studies in a given group were similar to each other. If they were not, the overall *d* was considered to be artificially increased or decreased by these "outliers," and they were omitted for a second calculation of a truer group effect size. Outliers were also analyzed to discover any common factors which made them higher or lower from others in the group.

GENERAL FINDINGS ON EFFECTIVENESS

The studies included in the analysis varied considerably from each other in focuses, procedures, materials, and findings. This lack of standardization makes summarizing and drawing conclusions across studies very difficult. Therefore, conclusions based on these data must be viewed as tentative until more studies can be produced to verify the findings.

The following table shows the topics, levels, and years covered by the studies. As this table indicates, most studies were either in reading or mathematics. The majority of these were in basic skills areas, and most were microcomputer-based. Also, if the sample used in this review is any indication, research is on the rise in recent years, with almost three-quarters of the studies reported during the period from 1985-87.

Table 1
Topics, Grade Levels, and Years of Study Reports
of Studies Included in Meta-analysis

	TYPES OF SKILLS					GRADE LEVELS			STUDY YEARS		
	Math	Read./Lang.	Science	Cog. Skills	Other	E	S	C	80-82	83-84	85-87
Dissertations	20	19	1	7	2	24	12	4	1	16	27
Other studies	16	14	4	9	1	21	11	7	5	9	24

Available data indicate that computer applications have been effectively used in education, but more effectively in some areas than others. Table 2 summarizes effect sizes across general categories of interest to educators and educational decision-makers. This table gives the effect sizes found in both the first test of homogenity and in the second test, after outliers were removed. If the *p* is NS or "not significant," the probability is greater than 95% that the effect sizes are homogeneous, or do not vary significantly among themselves.

In contrast to the findings of past meta-analyses, computer applications were found to be more effective at the college and adult level. The finding that science studies yielded significantly higher effect sizes than other content areas also differs from previous reviews.

Table 2
Various Categories of Effects by Computer Applications on
Student Achievement and Attitudes

CATEGORY	EFFECT SIZES			
	Original Set		Reduced Set	
Achievement in:	*d*	p	*d*	p
Elementary	.32	$p<.05$	.29	NS
Secondary	.19	$p<.05$	.19	NS
College/Adult	.57	$p<.05$	.66	NS
Mathematics	.36	$p<.05$	.37	NS
Science	.49	$p<.05$	.64	NS
Reading/Language	.26	$p<.05$	.30	NS
Cognitive skill	.35	$p<.05$	.28	NS
Low-achieving students	.45	$p<.05$	.36	NS
Regular students	.32	$p<.05$	.22	NS
Males	.19	$p<.05$	.31	NS
Females	.18	$p<.05$	.12	NS
Attitudes toward:				
Self (self-confidence)	.25	NS		
School and subject matter	.28	NS		
Computer as medium	.16	NS		

Applications in other areas achieved lower effect sizes, but appear to be about equally effective among themselves. No support was found for the hypothesis held by many in education that computers are more effective with low-achieving students than with regular students. Males seem to achieve more than females when using computers, but not significantly so. Student attitudes toward themselves, content and school, and toward using the computer as a medium of instruction seem to be positively effective, but there is a 95% probability that effect on attitudes toward computer methods is not different from zero.

FINDINGS ON EFFECTIVENESS IN SPECIFIC AREAS

Information about the general effectiveness of computer applications is useful, but educators also need more specific data on which to base their decisions about how best to use computer resources in the future. To help answer these questions, data from the studies were analyzed in several different combinations. The results of these analyses are described below.

Effects in Mathematics and Reading/Language

To determine if effects were higher when computer were used for various purposes, data from mathematics and reading/language studies were analyzed by type of computer application and kind of mathematics or reading skill being taught. The results of these analyses are shown in Table 3. These data indicate that both computation and higher level skills like math concepts and problem solving all yield about the same level of effects. Also, drill and practice, tutorials, and other kinds of computer applications are all about equally effective. When outlying studies are removed, the "other" category of computer applications yields a slightly higher effect, but not significantly so. Although it would have been useful to analyze findings from specific types of computer applications for specific skill types, there were not enough studies to make such results meaningful. The results for reading indicate that tutorial applications produce higher results than other types, although this figure was not significant at the .05 level. Also, computer applications seem more effective in teaching word analysis skills, although the difference among effects for reading skills was not significant.

Table 3
Effects on Mathematics and Reading/Language Areas
by Type of Skill and Type of Computer Application

CATEGORY	EFFECT SIZES			
	Original Set		Reduced Set	
Mathematics:	*d*	p	*d*	p
Drill and practice	.25	p<.05	.20	NS
Tutorial	.22	p<.05	.30	NS
Other applications	.20	NS	.38	NS
Computation skills	.24	NS		
Concepts/problem solving	.26	NS		
Reading/language:				
Drill and practice	.26	p<.05	.25	NS
Tutorial	.41	NS	.41	NS
Other applications	.32	NS	.32	NS
Comprehension	.21	NS	.21	NS
Vocabulary	.31	p<.05	.32	NS
Word analysis	.55	p<.05	.55	NS
Language	.30	p<.05	.28	NS

Effects in Other Areas

Table 4 shows the effects resulting from other areas of interest. Only four ESL studies were located, but the trend among these is not positive, indicating that non-computer methods are more effective than computer ones in these studies. Word processing seem to achieve small positive effects over the eight studies analyzed. Using Logo to teach problem solving seems to yield positive results, but using unstructured CAI results in an effect size which is probably not significantly different from zero. The most promising results in the review are in the area of using applications like Logo programming to enhance student creativity.

Table 4
Effects on Achievement in Various
Content and Skill Areas

CATEGORY	EFFECT SIZES			
	Original Set		Reduced Set	
	d	p	*d*	p
ESL studies	-.05	p<.05	-.11	NS
Word processing uses	.23	NS		
Problem solving with Logo	.39	NS		
Problem solving with CAI	.20	p<.05	.01	NS
Creativity	.73	NS		

SUMMARY AND DISCUSSION

The results of this review indicate that computer applications have small positive effects over non-computer methods in most content areas and with most types of students. However, educators should use caution in using them with the ESL area. Particularly recommended for further use and study are applications in science (especially simulations), teaching of reading comprehension, and applications to enhance creativity. The small number of studies in this review requires that we view these findings as tentative. An increased level of research is critical if future computer use in education is to be based on concrete evidence of effectiveness, rather than beliefs and hypotheses.

DESIGNING COMMUNITY-ORIENTED COMPUTER EDUCATION PROGRAMS: LESSONS FROM YOUNG PEOPLES UNIVERSITY AND YSLETA INTERVENTION PROJECTS

Brent Edward Wholeben†

ABSTRACT

Two longitudinal research and development projects, the Computer Literacy Project of Young Peoples University (1983-85) and the Ysleta Project on Computer Education® (1986-87), demonstrated the viability of structured, community-based, computer literacy and computer science instructional programs. Each program offered a developmental curricula to primary and elementary school-aged children and their parents in a five-week regimen. Parent-child interactions were specifically designed to reinforce learning through a resource-sharing relationship. A total of 45 instructional modules were piloted and critiqued for a 9-month period, addressing each of the continuum objectives for primary and elementary school participants. Participation of professional educators in local school districts as teaching practicum assistants facilitated the exportation of this program into individual schools and their attendance-service catchment areas.

INTRODUCTION

The demand for computer literacy instruction for elementary and secondary school students, whether voluntarily (internally) enacted or state legislation mandated, has resulted in a wide variety of ethical and legal dilemma for teacher educators and elementary and secondary school teachers (ref 1). In many cases, the most serious of these dilemma surround the adequate training of teachers of computer literacy, and the appropriate computer literacy teaching of students who receive such instruction in the elementary or secondary classroom. On-going monitoring of international trends produce reliable interpretations which conclude that little agreement exists for 'who' whould provide 'what' training, 'when' and where', and 'how'; and, in many cases, even 'if' such training should be provided at all (ref 2,3).

Regardless of these ongoing debates, little longitudinally-based evidence exists which suggest what levels and types of computer literacy curricula can be effectively and efficiently taught to which grades of students. Even less empirical evidence is available which would suggest the differential characteristics of such indices as instructional psychology, curricular paradigm, and learning styles that impinge upon the successful computer literacy teaching of different students (ref 4). Furthermore, the satisfactory training of classroom teachers who will participate in such literacy instruction has not been well defined by either teacher educators (preservice) or school district administrators (inservice). Finally, elements of supervision and control of the computer assisted instructional environment are still often perceived as equivalent tactics to those employed in other technology-free, teacher-student settings.

†Department of Educational Leadership and Counseling, College of Education, University of Texas at El Paso, El Paso TX 79968 USA

This report briefly summarizes the results of two studies in a five-year longitudinal research and development effort whose mission was the design, development, and testing of instructional psychologies and curricular paradigms for providing computer literacy instruction to grades K-8. Both studies sought to investigate (a) curricular content, (b) instructional psychology, (c) delivery strategies, (d) differential learning styles, (e) content-process paradigms, (f) supervision and control techniques, and (g) assessment methodologies, relevant to the provision of computer literacy instruction to diverse elementary school students and their parents.

YOUNG PEOPLES UNIVERSITY

In 1982, the Young Peoples University Project on Computer Literacy (YPUCL) was implemented under the auspices of the University of Texas at El Paso, USA. Piloted during the spring and summer months of 1983, and fully operational commencing Fall 1983, YPUCL served approximately 500 K-8 grade students annually throughout three separate semesters (fall, spring, summer), until budgetary limitations discontinued the program in 1986. Integrated within YPUCL were three distinct components: teaching (including literacy instruction and internship experiences for future district-based literacy programs), research (including curricular paridigms and instructional strategies for different age levels of students), and service (including a range of instructional activities, from general awareness to advanced graphics programming, for metroplex-area children between the ages of 5 and 14 who desired computer training.

The Young Peoples University Project on Computer Literacy was composed of five distinct instructional units: (1) general awareness and literacy for grades K and 1-2, (2) beginning computer programming and software development in BASIC for each of grades 3-4, 5-6, and 7-8, (3) advanced computer programming in BASIC with an introduction to low resolution computer graphics, (4) advanced high resolution graphics programming, and (5) programming applications in LOGO. Instructional sections consisted of 15 contact hours (5 sessions of 3 hours duration each), with the exception of the general awareness and literacy for grades K and 1-2 which comprised only 6 contact hours (four sessions of 1.5 hours each). Sections were scheduled on microcomputers with two students per unit.

The instructional paradigm for each section was based upon the sequence: awareness, demonstration, structured practice, extension, and original application. All units were highly structured by 15-minute intervals. Reading and other study materials were employed in addition to corollary discussion techniques. Hands-on use of the computer accumulated 90 percent across all units.

To provide for a valid and reliable incorporation of research results within area elementary and middle schools, classroom teachers who had completed six graduate hours of instruction in topics related to (a) computer programming, (b) courseware design and development, (c) theory of computer assisted and computer managed instruction, (d) courseware evaluation, and (e) legal and ethical aspects of the use of computer technology in the classroom, served as teaching assistants for one of more of YPUCL's instructional offerings.

YSLETA PROJECT ON COMPUTER EDUCATION

Discontinuance of YPUCL in 1986 led to the development of the Ysleta Project on Computer Education® (YPCE®), a Texas-registered community-action program, which incorporated each of the empirical findings interpreted from three years of YPUCL. Specific curricula was developed for each of the groupings: kindergarten, grades 1-2, grades 3-4, and grades 5-6; with per-session contact hours, respectively, of 1, 1.5, 2, and 2.5 hours. LOGO and BASIC were the languages of instruction, accompanied by several diverse CAI/CMI packages in each of the humanities, social sciences, and natural sciences.

YPCE optimized parent-involvement, allowing parents to receive each unit of instruction while accompanying their child(ren). YPUCL data revealed the importance of differential time-durations based upon the age of the student, findings which were incorporated in the design of YPCE. In addition, YPCE allowed more structured opportunities for following students longitudinally throughout their developmental grasping of technology and its deployment physically.

Depending on the current primary or elementary grade level of the student, three different types of classes were offerred.

The first class, Introductory Computer Literacy and Awareness, Grades K and 1-2, was concerned with helping the child understand what a computer is, how it works, and what it can do in a variety of situations. Each student had the opportunity to use different computer programs which covered a large number of topics, including computer-assisted instruction in the areas of arithmetic, reading, and problem-solving. Special programs which used "games" to teach topics in science and other subjects were also introduced. For example, students were introducted progressively to single and multiple letter recognition, syntax and parts of speech, and arithmetic reasoning. Dominant and subordinate eye-hand motor coordination were incorporated within many exercises, often challenging parents to compete with their child(ren). Games employing higher-order reasoning and strategic logic were utilized, each requiring a different feature of the keyboard. Social studies and natural science simulations were deployed to demonstrate the computer as a calculating appliance.

The second class, Problem Solving Exploration and Applications, Grades 3-4, introduced the child to the use of the LOGO programming language. LOGO helped the child develop problem solving skills through the use of graphics. This class also explored how the different parts of the computing machine cooperate to do its work. Special, pre-designed exercises assisted the child to learn the relationship between mathematical concepts in geometry and the use of these concepts in such occupations as engineering and architecture. Elements of plane and solid geometry were discussed and demonstrated, including tangents, n-dimensional vectors, and orthogonal layouts for mechanical drafting.

The third class, specialized Language Programming and Software Development, Grade 5-6, taught the basic concepts of high-level computer programming through the use of the BASIC language. Students learned how to write their own programs, including personal programs which check arithmetic homework; in addition, they learned how to write "games" using the BASIC language. Special, pre-written programs demonstrated how the computer understands different aspects of the programming language, and how the program software actually "teaches" the computer what to do. Functions and matrix commands were discussed in addition to the usual display, transfer, store, and conditional operant statements. Students were able to construct 'number guessing' (from randomization) programs and graphics-simulation displays (utilizing loops) at the conclusion of five weeks of training.

EDUCATIONAL SIGNIFICANCE

Findings from both YPUCL and YPCE demonstrate indisputably that computer literacy can be very effectively taught to lower primary and elementary school students as well as secondary students. The ultimate success of such literacy intervention is dependent upon differential elements of curricular paradigm, instruction psychology, and teaching strategy. Important also are the different methods of classroom supervision and control, individualized pacing of student efforts, and monitoring and evaluation techniques that must be in force during the literacy sessions. Paired student groupings per machine will allow the most optimal use of limited machine resources, and provide an instantaneous environment for student interaction, self-help, and discussion. While different laboratory configurations are possible, many of the more popular layouts were not deemed functional.

Total reliance of the teacher upon pre-packaged materials, a common practice for many school districts, demonstrated problems where were immediately evident. Students were found to be quite capable of heuristic and other inductive approaches to software development which far surpass the standards imposed by any state agency of education. Lastly, the ability to provide structured inservice opportunities to classroom teachers within a computer science environment has vastly improved the local districts' literacy requirements in the years ahead.

REFERENCES

1. B E Wholeben, Educational Malpractice for Computers in Instruction: A Perspective for Legal Advocacy, AEDS, 9-2, 142-161 (1986)

2. B E Wholeben, Ethics in the Intellectual Marketplace: The Computer Software Issue, Collegiate Microcomputer, V4, 320-326 (1987)

3. G D Brooks, B E Wholeben, and S Boswell, Computer Education in the USA: State Policy on Training, Instruction, and Control, 1987 NCC Proceedings, 56, 205-213 (1987)

4. G D Brooks, B E Wholeben, and S Boswell, State Policy Initiatives in American Computer Education: Resource Documentation for Strategic Program Planning, University of Texas at El Paso (1987)

COMPUTERS IN THE CLASSROOM

John DeWitt

ABSTRACT

The School District of Escambia County, Florida, has had significant improvements in test scores of potential dropouts since implementing computer integrated systems. The results have shown over one month's gain in students' reading and math performance for each hour on the computer. Additionally, the role of the teacher has been significantly changed in that precise data on a student's learning performance is maintained, specific strands in deficit areas can be pinpointed for assistance, and the computer becomes an integral tool in the instructional process. The variety of courseware available has also made it accessible to a wide range of students from K to adult and from handicapped to gifted.

REVIEW OF DISTRICT'S PLAN

The School District of Escambia County has been concerned about the high rate of dropouts from its high schools. In a review of the research available, the following major characteristics of this population were noted: 1) the dropout rate for the nation was approximately 27%, Florida 36%, and Escambia County 40%; 2) of all the reasons for dropping out, low functioning levels in basic reading, writing, math, and language arts are the most contributing factors; 3) economically disadvantaged youth lead the way in dropping out: 76% of economically disadvantaged youth function at one or more grade levels below their actual school attainment level (ref. 1). Based on these factors, the district decided to implement a comprehensive computer assisted instruction program focusing on the high risk population of economically disadvantaged youth as the target population. The decision to use a specific CAI program was researched, and the specific issues in making the decision included the need for a system which could 1) relate to identified needs of students by providing both academic and remedial programs through drill and practice, tutorial, and skill building and 2) which provided for an individualized curriculum which could be used for kindergarten through adult and be controlled as to movement. District staff reviewed various hardware and software configurations and made their recommendation based on the following factors:

1. Does system meet the needs of various student populations?
2. Is the system based on sound learning theory?
3. Is there research to validate the program and student gains?

---

1. H. L. Hodgkinson, All One System, 1985

Director, Research and Grants
School District of Escambia County
30 East Texar Drive
Pensacola, Florida 32503

4. Is the system integrated by being able to track individual students, provide for teacher control, allow for student choice, and provide detailed reports?

Based on the information received and researched, the district purchased the Computer Curriculum Corporation (CCC) System which is a highly sophisticated, integrated system of hardware and software allowing for a MICROHOST and up to 125 Atari SL1040X terminals to be connected either directly or through telephone data lines.

This unusual system, consisting of 16 terminals, was installed in a high school for a summer tutorial program. Based upon the success of that program, students were added for the 1986-87 school year; and in December of 1986 the district expanded the system to six additional high schools with a total of 88 terminals attached to the MICROHOST. Since 1986 the district has again expanded the system to additional locations including adult programs, detention centers, and the area Vocational/Technical Center.

POPULATION SERVED/GAINS

The first semester of 1986 the system consisted of 16 terminals located at Pensacola High School. The program began in October with 247 students, of which 60 were verified economically disadvantaged. During the 3½ months the lab conducted 5,243 student sessions of 20 minutes and realized an average grade level gain of .55 in reading for comprehension and .22 in math skills.

The second semester, January 22, 1987 - May 27, 1987, the system was expanded to 88 terminals for use by 1,366 remedial and tutorial students and 196 enrichment and academic skills students. Of this total, the following breakdown will demonstrate the program:

	School Year 1986-87		
Number of Students	1,562		
Number of Sessions (20 min.)	62,529		
Number of Classroom Teachers	67		
Number of Dropouts -			
of Total Population	24		
of Economically Disadvantaged	2		
Results for 1,366 Students:		Gain	Time
Reading for Comprehension		.48	8:34
Math Skills		.64	11:45
Language Arts		.35	6:10

In addition to the data presented above, about one-third of the students topped out of their originally assigned course and were working in the next higher level course. Although these data covered only four months of school, the preliminary results were encouraging. A survey conducted among the teachers whose students were participating indicated significant attitudinal changes of students, increased attendance, and a more positive feeling about themselves. The 1,366 students were selected from the following classes: 1) remediation, 2) basic skills English, 3) fundamental math, 4) reading. The additional 191 students who participated included students from Gifted classes, Special Education, and adult GED.

During the summer of 1987 the program included four specific projects.

Students participated four days a week for six weeks. The following summarizes these programs:

Program	Number Students	Number Sessions	Courses
Summer Youth	330	2,875	Reading/Math
Economically Disadvantaged (8th grade, 3 weeks)	250	4,979	Reading/Math
Summer School	980	6,901	Algebra/Math English Reading
Middle School Summer Camp	75	2,536	Math/Science Computer

Although the time on the computer was too short to indicate any substantial gains, each student did indicate some gain (2 months gain for every hour on the computer).

For the first three months of the 1987-88 school year the following results have been obtained:

Total Participants	1,573	Average Gain:	Reading	.53
Total Sessions	33,001		Math	.72

The gains are reported generally; however, each report provides specific data to the teachers which they can use in providing direct instructional support.

TEACHER BENEFITS OF CAI

One of the most significant impacts of the CCC system is the feedback it provides to each teacher on student performance. Each teacher can access the following specific reports on their students:

1. report which shows current status in a course,
2. report which helps group students by skill areas in which performance is lowest,
3. report which details student progress over time.

Specifically, the course report will provide precise data on each student's performance in a particular course. For example, a math skills course report would provide the following information to the teacher for each student: 1) number of sessions, 2) amount of time on system, 3) total attempted, 4) total correct, 5) strand areas specific scores which would break math processes into 10 specific components such as addition, subtraction, fractions, etc.

The teacher is able to access this data as frequently as needed and can then either use the data to plan her instructional program or to request specific work on the computer system for the student. An additional unique feature of the system is its ability to generate homework sheets for the student per teacher request. The assignments can be in a student's lowest area, area of strength, or random questions. Using the power of the system, the feedback it provides, a teacher can maximize a student's learning opportunity and achieve dramatic instructional results.

In addition, the school administration has been able to use gains reports in evaluating teacher effectiveness with student learning. Teachers who can effectively work with data and help students have shown tremendous gains on reports.

The final software program that has been installed in the district is the "Individualized Prescriptive Strategy" (IPS) program which forecasts achievement. This program can pinpoint when a student or group of students will reach a performance goal. The IPS program estimates a student's future progress in a CCC course and forecasts the amount of CAI time the student will need to reach the goal. This system will allow teachers to plan the amount of time needed on the system to achieve a performance level or to predict within 99% accuracy the performance level of a student based on the time the student participates in the CAI lab.

A related benefit for teachers has been their own use of the system. Teachers have enrolled on the system during their planning periods or after school to participate in some of the advanced courses that are available. These include Introduction to Logic, Computer Literacy, Computer Language, and Programming.

SYSTEM INFORMATION

The Computer Assisted Instruction system purchased by the district is from Computer Curriculum Corporation, 1070 Arastradero Road, Palo Alto, California 94304. The system consists of an individualized instruction program spanning kindergarten through adult levels. It is estimated that there are over 2,800 hours of daily instructional sessions in all subjects including math, reading, language skills. The second software package includes an automatic record keeping and reports section which is comprehensive and can be totally individualized for a student, a teacher, or a school.

The hardware consists of a MICROHOST, which is centrally located and can operate up to 128 stations throughout the district. Each station is an Atari 1040ST Computer which can present all CCC courses or run as a stand-alone on software developed for the 1040ST. In addition, each school has a CITOH C210 parallel printer to run reports or homework assignments and CCC Graphics Servers which enable processing to be distributed between the LS1040 and the MICROHOST computer. The system has capability to be expanded to include both a Speech System and Telephone Access Unit, which would permit broader use of various courses and accessibility to students at home to Dial-A-Drill courses.

The district has experienced minimal difficulties in maintenance or down time for the system. Each lab has a spare Atari on stand by and can easily replace a computer. The MICROHOST can be accessed by phone from corporate office to deal with specific programming issues. In summary, the system provides a comprehensive, reliable software and hardware package that meets the needs of a school and a district.

THE FUTURE

Based on the tremendous results with student gains, the future of CAI is promising. No number of computers will ever replace quality teaching and dedicated teachers; however, CAI will become a critical tool for successful teachers. The computer will be helpful in reorganizing their tasks so that much of the paperwork and record keeping can be assigned to the new technology, thereby freeing them to spend more time in interaction with students.

050

PLANNING, PILOTING AND PRODUCING AN INTERACTIVE VIDEODISC

J. Mashiter*

ABSTRACT

This paper will present a discussion of the application of evaluation checklist for the design and realisation processes of an educational videodisc.° Recent research in the field of cognitive psychology, visual interpretation skills and intelligent computer assisted learning should be applied to videodisc and any technological approach to education

THEORETICAL BASE

A currently favoured model for effective learning is that of the student being engaged in active processing. In order that this active processing might be maximised, the role of any learning technology is to keep the level of activity high by responding to the learner's needs, which are unique to the individual. Interactive video (IV) has the potential to accommodate many learners' needs. The evaluation criteria can, for this discussion, be placed in three groups which match the facilities offered by IV:- diagnostic tools, control facilities and the range and flexibility of learning permitted.

DIAGNOSTIC TOOLS

The elicitation of a learner's prior knowledge of facts is not difficult. The computer software can incorporate a question bank and provide branching through the questions. With advances in software tools which allow for rapid keyword searching and partial matching, combined with the very small access time to any visual material on videodisc, it is possible to glean an informed picture of the learner's knowledge and its associated structure. Both dynamic and static images can provide a powerful communication channel between software and learner. Flexibility and ceaseless patience enable a closely matched concept map to be given by the user and a valuable reference framework for learning to be established.

In order to allow the learner to select the most appropriate style of learning, he or she must be aware of the dominant characteristics of the available styles.

The role of metacognition is increasingly being emphasised in education. A feature of IV is that the learner need not be locked into one learning style - they are able to change at many (predefined) points. In science education, there is currently much attention paid to constructivism; the need to begin teaching from the student's resident (mis)conceptions and (mis)understandings. IV discs permit such an approach. Although only a finite number of misunderstandings can be predicted, the learner soon should be able to 'pull apart' their own faulty or incomplete concepts and hopefully replace them with ones which better explain the phenomenon.

°School of Education, University of Newcastle upon Tyne, UK.

RANGE AND FLEXIBILITY OF LEARNING

IV has the capacity to hold a variety of presentational approaches to a particular topic or conceptual structure. On first meeting new material a student is unlikely to be able to make a wise judgement concerning the most suitable approach for him or herself. If however they have previously, using familiar ideas, identified a preferred learning style, then this can be offered as a best introduction to those which are unfamiliar. The facility to change learning styles can be constantly available through the selection of on-screen icons. Some features which may characterise the different styles provided are the use of graphics (which may be in annotated or evolutionary form), the language level (both on audio tracks and in written text) and the provision of references to related resources.

CONTROL FACILITIES

There is an established, simple method of presenting choices to a student. Some form of menu appears in most CAL programs. As a selection mechanism, it is difficult to fault. With imagination, a menu on interactive video can be cleverly disguised and may even, if desired, be implicit. An observer brings their own interpretation to an image. By transparently defining certain areas of a picture, the IV software can 'understand what the user is pointing at (and why)' and provide appropriate action. It is for such reasons that the camera framing of the image can be crucial - the producer must specify precisely the requirements and the cameraman adhere to them. (An advantage of shooting video as opposed to film is that images can be previewed in real time.) The icon with mouse-and-pointer environment is rapidly pervading the educational computing world. Symbols or words which are permanently on the screen, or are summoned via a pull-down or pop-up menu can become an efficient and readily usable tool for student control of learning. The graphical design of these and their predicted frequency of use also must be considered when planning screen material. The control of, and responsibility for, learning can have a significant effect upon the learner. However, research has shown that this effect is not always beneficial (ref). In addition to the careful use of diagnostic techniques, the supply of appropriate feedback may avert some of the dangers. With IV, feedback can take many forms. A decision in an interpersonal, role-playing situation, or parameter setting in an experimental simulation can be answered by visual and/or verbal responses. The consequences of a decision can be demonstrated. The IV designer must take care in this learning-by-mistakes philosophy. Opportunity should be given for the learner to retrace their steps and recover from a mistake as realistically as possible. The environment is conducive to 'what if ...' experimentation by which valuable learning can take place. Essential for this is a balance between forcing the student to accommodate the consequences of their decision and offering them the security of being able to alter their input and experience a different result. In the planning stage of a disc, this can be achieved through the use of flowcharting techniques which enable feedback and recovery loops to be identified.

In the conference session, an example of the realisation of interactive videodisc design will be described.

°For a suggested list of criteria agains which an interactive videodisc might be evaluated, and its research foundation, see the paper "Learning and Teaching with Interactive Videodisc" by M.J. Atkins and G. Blissett.

Reference

G. Gay, J. of Ed. Psychology, 78(3), 225-227 (1986)

THE TEXAS LEARNING TECHNOLOGY GROUP: PHYSICAL SCIENCE PROJECT

Clifford A. Hardy*

ABSTRACT

The number of interactive videodisc learning projects are increasing rapidly. An exemplary curriculum project of this nature can by illustrated by the Texas Learning Technology Group - Physical Science Project. In 1985, the Texas Association of School Boards undertook the task of bringing together a diverse group in order to provide advanced learning technology to Texas school districts. Their efforts have resulted in the development of the Physical Science Project: a complete, technology-based delivery system integrating computer, video, and audio technology programs. Important aspects of the program include teacher training and involvement, the involvement of higher education staff in curriculum review and teacher training, and a thorough coursework evaluation plan.

BACKGROUND

The educational reform movement in the United States has generally placed new stress on the teaching of science and mathematics. This movement appears to have come none too soon, since a National Science Teachers Association survey has shown that over 7,000 of the nation's 16,000 high schools offer no physics courses, while over 4,000 offer no chemistry courses and approximately 1,900 offer no courses in biology. In addition, it has been shown that only about one-third of the students in Grades 10 through 12 are enrolled in science courses. It would appear that traditional teaching methods are failing to challenge young people to pursue courses and careers in science and technology. At the same time, Texas schools have been experiencing a growth in the number of unqualified teachers being assigned to teach science and mathematics (ref 1). Along with this trend, there there appears to be a decline in student interest and learning, as reflected by Texas high school graduates' achievement test scores.

Perhaps a hopeful change in direction can be seen in the rise of computer technology in the schools. The number of computers in schools at the national level has steadily increased to just over one million twenty thousand units (ref 2). Their use in many different subject areas has resulted in the computer becoming a major educational tool in the learning situation. The growing use of the electronic classroom as personified by the Texas Learning Technology Group (TLTG) Physical Science Project hopefully will greatly enhance the quality and effectiveness of science education and classroom teaching on a national scale.

ORIGIN

Formed in 1985, the TLTG is coordinated by the Texas Association of School Boards, initially funded with a $500,000 grant from the National Science Center Foundation and an additional $1.5 million contributed by 12 Texas school districts.

*Department of Secondary Education, North Texas State University, Denton, Texas 76203

The efforts of this group have resulted in the development of a complete technology based delivery system integrating computer, video, and audio technology programs. Important aspects of the program include teacher training and involvement, the involvement of higher education staff in curriculum review and teacher training, and a thorough coursework evaluation plan.

CURRICULUM

The electronic based curriculum will span 160 hours or two semesters of physical instruction, with the teacher leading the students through small group and laboratory activities. The role of the teacher is shifted in the process to that of a classroom manager, as opposed to the traditional performer. The teachers are being trained on an ongoing basis in a process that will ultimately be assumed by selected Texas universities that will offer courses in videodisc application.

The laser disc computer program utilizes the IBM Info-Window touch screen application and combines the qualities of a television program with the capabilities of a computer. The curriculum is packed with unusual scenarios designed for student motivation but yet presents a firm foundation in the physical sciences. For example, when students want more in-depth information about a scientific concept or fail to grasp a concept, the computer program allows them to see the scientific principal approached from a different angle by a different narrator and different illustrations. In addition, the program allows students to work at their own pace. Slow students each advance through the basic work and if they still do not understand, they can ask the computer program for another run-through. The touch-information windows will also allow handicapped students to activate the program with a pencil or pointer. An infrared grid overlay, rather than heat sensors, makes it possible for handicapped youngsters to control their learning and even conduct scientific experiments.

The program is now in its first year of field testing in selected Texas schools and the project is undergoing a thorough and realistic evaluation. The physical science courseware and other courseware developed by the group will be evaluated for effectiveness in two ways. First, the Texas Education Agency will conduct independent evaluation of the effectiveness of the courseware. Second,the Texas Learning Technology Group has established an evaluation methodology based on the input-output model developed by the University of Texas Educational Productivity Council. The Texas Education Agency has approved the Educational Productivity Council's model of course evaluation for the physical science course. The approval was confirmed through the Deputy Commissioner of Research and Information (ref 3).

REFERENCES

1 National Center for Education Statistics. The Condition of Education. Washington, D.C.: U.S. Department of Education (1983).

2 Educational Technology 1987. Electronic Learning, 44, 39 (1987).

3 TLTG Explores New Horizons. (Texas Learning Technology Group: Austin, Texas, 1987), p 1.

THE DEVELOPMENT OF A SIMULATED BUSINESS ENTITY AS A LEARNING VEHICLE

W Richardson* G J Worsdale+

ABSTRACT

Todays dynamic and hostile business environment requires Polytechnics to introduce into Business Studies programmes modern tools for business decision making. Polytechnics, too, need to use the same tools to improve the performance of their own teaching systems. This paper describes a programme recently embarked upon at Sheffield City Polytechnic to integrate more formally Information Technology applications into business studies courses. It provides details of the model being developed and used at Sheffield as the framework for this integration.

INTRODUCTION

During the late 1960's and the early 1970's in the United Kingdom the first undergraduate business studies courses were being developed. The developments were taking place, in the main, within the newly established Polytechnics. A major catalyst for the developments was the Crick Report (ref 1) of 1964. This identified key discipline areas that would be useful for undergraduates to study before entering industry/commerce. The report argued that if the student was exposed to, for example, economics, accountancy, sociology, mathematics and in addition, spent part(s) of the course on placement within industry to give practical experience the graduate would be extremely useful to UK industry.

More recently as Polytechnics have sought to continue to meet the changing needs of industry/commerce Business Studies Departments have been established, staff with business experience have been recruited, new activities (such as consultancy) have been undertaken and the content, structure and "flavour" of courses have been amended.

At Sheffield Polytechnic, on our range of Business Studies courses, we now have a "core spine" of Business Policy related units. This development is one response to the increasingly critical need for businesses to recruit and develop business decision making sophisticates - at operational, tactical and strategic levels.

ISSUES RELATED TO ACHIEVING THE AIMS

Of course, information lies at the heart of decision making and information technology is having massive impact - for better and for worse on British organisational performance. The extent to which IT can be used to an organisation's advantage will depend significantly on the existence of personnel who appreciate and can make effective use of IT within decision making.

* Department of Business Studies
+ Department of Applied Statistics & OR, Sheffield City Polytechnoc,
Pond Street, Sheffield S1 1WB

At the Polytechnic organisational level IT might offer one strategy towards the resolution of a dilemma which sees Business Studies education gathering importance while the declining resources made available for its provision push us towards higher staff/student ratios.

Thus at Sheffield we are using IT to further a variety of aims, including:

1. The development of students capability in "hands on" usage of IT applications.
2. The development of student understanding of IT as an aid to business decision making.
3. The development of students who understand Business Policy and the decision making requirements of organisations.
4. The design of courses which continue to meet student, business and staff needs in an effective and efficient manner.

Like most academic institutions over the past five or six years, we at Sheffield have made considerable progress in our provision and use of IT. However until recently, progress was unstructured and consisted of an eclectic introduction of relevant packages as they became available. This process is still perceived as necessary but, in addition, we have now moved into a more structured phase of development. Part of this development relates to the aims identified above.

The Polytechnic has recently been awarded both equipment and finance from IBM to develop the learning materials for our undergraduate business studies programme. This project is linked to the Proteus development at Manchester Business School.

THE SHEFFIELD MODEL

The materials being developed are centred upon the core curriculum for the undergraduate degree programme in Business Studies and International Business. The structure of this core curriculum is given below.

	UNIT TITLE	INDICATIVE CONTENT
Year 1	Business Functions	Organisations adapting to environments. Organisational structures, the operations and responsibilities of the marketing, production, personnel and finance functions, the external influences upon the functions, the information needs of functions and the organisational information system.
Year 2	Business Decision Making	Quantitative and qualitative aspects of decision making in organisations and the economic and social effects on the organisation. Use of analytical tools for decision making. The behavioural aspects of decision making. The need for efficiency through people.

Year 4	Business Policy	Strategic planning within both profit seeking and public organisations taking account of external influences, ambiguities of information and organisational aspirations and resource factors.

YEAR 1 - BUSINESS FUNCTIONS

The majority of students entering this programme have little or no knowledge of business organisations nor will they have significant knowledge of IT as it is used within organisations. However, before starting this unit, students are given an introduction to the use of the Polytechnics hardware and software for wordprocessing, spreadsheets, databases and for drawing diagrams.

The material being developed seeks to enhance their understanding of business operations and to extend and improve relevant IT skills.

The basic content of the course is expected to be delivered through the traditional lecture plus case material. The first two weeks concentrate on basic organisational structures and procedures. Each functional area is then allocated two weeks to give an understanding of the responsibilities of the particular function. For each, the first week's tutorial is computer based and the second is of the more traditional type but is based around the work done by the students in the first of the tutorials. Following the first of the tutorials the tutor is provided with a system produced summary information sheet giving details of the students strengths and weaknesses. The tutor will focus the tutorial on particular aspects of the material.

Part of the computer based material is used to check on the students' basic understanding of the functional area, directed reading references being given if there is a lack of understanding. More significantly the material will also give the student experience in the types of tasks undertaken by functional managers. Two examples are given below.

Marketing : The student is given case material on a small privately owned coach company. The student is required to design advertising copy of an appropriate style and size for inclusion in a local newspaper. The task is to be done using a Desktop Publishing package.

Production : A bakery has just one product. Daily demands for the product are given. The production rate and working hours are given and the student has to produce a production schedule taking account of product life and distribution factors. Complications are added which give rise to problems of overtime and under utilisation of capacity. The final task is to develop a spreadsheet model for planning and controlling the production and the stock.

Each of the exercises associated with the functional areas require the student to identify the information needs of the function's management. The results are then used as the basis for discussing, in the last part of the unit, organisational information systems.

YEAR 2 - BUSINESS DECISION MAKING

The unit starts by reinforcing the importance of good organisational information systems. This is to be assisted through the medium of the communications game, Protocom, developed at Manchester Business School. The game requires the marketing, production, finance and managing directors to effectively use information and communications software to control the 'company'.

Further associated teaching materials are to be developed that will enable students to be competent users of statistical and modelling software commonly used in business. The unit will also develop the students' awareness of behavioural factors associated with decision making and will culminate in a series of case studies which will require the student to bring together the various aspects of decision making.

YEAR 4 - BUSINESS POLICY

The development of materials for this stage of the course is only at a preliminary planning stage. However, it is envisaged that the material developed will bring together internal information, external databases and the software commonly used by organisations for strategic planning. The Polytechnic has considerable experience of developing material of this type although not necessarily of a technology based nature.

CONCLUSION

The article has tried to indicate the types of developments that are taking place at Sheffield Polytechnic. A conscious decision was taken to base the material around a particular course initially. Clearly the developments are in their infancy and give rise to resourcing implications which will need to be addressed. We do envisage that the materials will be used on a range of courses at Sheffield Polytechnic where the development of IT skills in the context of business decision making is required. In total we expect this development to provide a complete learning entity.

REFERENCES

W F Crick : A Higher Award in Business Studies : Report of the Advisory Sub-Committee on a Higher Award in Business Studies, HMSO.

USING THE TECHNOLOGY OF ON-LINE FINANCIAL INFORMATION IN TEACHING

T.S. HO*, S.J. MCLEAY+, J. O'HANLON* AND R.J. WHIDDETT~

ABSTRACT

The great advances in computer and information technologies of recent years have led to a radical restructuring in the organization of the world's financial markets and the way in which the financial services industries operate. Two significant changes have been due to the rapid evolution of communications technologies: firstly, financial transactions can now be implemented online; and, secondly, improved access to remote databases has enabled financial decisions to be based upon more detailed and precise information.

Institutes of higher education need to respond to these changes by incorporating into the computing component of their finance and business studies courses a greater awareness of the importance of on-line financial databases. This paper discribes the development of a teaching laboratory based upon personal computers connected by a Local Area Network (LAN) which is connected to a Wide Area Network (WAN) to local mainframes and to remote databases, and outlines the way that these facilities can be used in teaching.

INTRODUCTION

In the areas of Accounting and Finance there is at present an urgent need to develop approaches to computer-aided learning that are appropriate to these applied disciplines, and to design specialised computing laboratories. Indeed, given that the operations of the financial sector are now largely conducted through electronic networks, it seems particularly important that the radical changes in the workings of the financial market places should be reflected in teaching programmes. For those who study Accounting and Finance at university, it should be possible to provide at the very least some kind of window on the financial world via properly designed laboratories equipped with workstations for data trapping and analysis, with access both to the commercial networks and to large financial data sets stored locally.

In many universities, the infrastructure already exists that will permit such developments. For instance, it is now usual for the computing facilities that are used in teaching and research to be based on backbone networks linked to terminals, and for workstations to be distributed around the university in a way that suits the particular needs of each of the groups of students and researchers using them. In many cases, these workstations are linked to the central computers, providing large filestore and access to mainframe based software, as well as to remote computers through the gateways. In the U.K., access through the university system's own JANET network now makes it feasible to provide direct access to the commercial financial information networks.

* Department of Accounting & Finance University of Lancaster, Lancaster LA1 4YX.
+ University College of North Wales, Gwynedd LL57 2DG.
~ Department of Computing, University of Lancaster LA1 4YR

HARDWARE RESOURCES

The initial resource room of computing facilities of the department of Accounting and Finance was acquired to support access to remote financial databases for various research projects. These computers were IBM-PCs and XTs equipped for data trapping and graphical analysis, with access through the national commercial packet-switched communications network, PSS, to the financial information networks and to large financial data sets of over one hundred Megabytes stored locally. The particular type of machine were chosen for two reasons: firstly, because they were the means of access that was preferred by the suppliers of the commercial databases to which the department had access; and secondly, because this was in line with Lancaster University's policy of using these standard machines. The serial ports of these machines are connected to a PAD(Packet Assembler, Disassembler) which interfaces between the RS232 protocols of the PCs to the internal X25 protocols of the campus network (Dhas, 1986). This connection allows access to the local mainframes, to remote mainframes at other universities via the JANET network and to commercial databases using the gateway between JANET and the PSS network. The link allows the PCs to act as terminals interfacing to the remote machine, and allows the transfer of files in either direction.

Subsequently a teaching laboratory was designed to complement the research facilities, and was therefore also based on IBM-PCs. Each of the student workstations consists of a basic PC with 640k of ram, two floppy disk drives, and an Enhanced Graphics Adaptor driving a monochrome display. Each teaching machine also has a serial connection to a PAD line via a multiplexer. As they stand, all machines provide a reasonable computing resource; however, their usefulness for teaching has been greatly enhanced by interconnecting them with a more powerful IBM-AT with a winchester disk using a Token Ring Local Area Network (Bux, et al., 1983) (see fig. 1).

The use of suitable network software, such as the IBM LAN Program, provides several benefits. Firstly, the files on the winchester disk may be accessed by any machine on the Token Ring network. This means that only a single copy of the programs and data that are used in teaching need to be produced or updated, which greatly reduces the problems of administration. Furthermore, the LAN program provides greater control over access to these shared files than that provided by the standard operating system, (PC-DOS), and users may be prevented from changing or creating files on the winchester disk. This avoids the problems of students either accidentally or maliciously corrupting files. Any temporary files of private data can be kept on removable floppy disks.

The network also allows each workstation to access shared peripheral devices. For example, the file-server also contains a gateway device which connects the Token Ring to the campus X25 network, this allows each workstation to establish a number of connections across the networks to mainframes, rather than using their serial ports and a PAD. The network also allows peripheral devices such as printers and plotters to be used in a coordinated manner by all the machines.

Finally, the inter-machine communication facilities of the network can be exploited for teaching. The use of the "broadcast" feature of the network means that it is possible for several of the machines to act as "slaves" so that their screen display echos that of the master machine, which is a useful way of demonstrating the use of the system. Also, the network offers very fast inter-machine communication which can be exploited to provide distributed real-time simulations of a transaction-based market in which each machine interacts with all the others.

DATA RESOURCES

The Department subscribes to a UK on-line financial information service called DATASTREAM and has integrated the resource into certain teaching programmes.The service is the second largest of a number of commercial databases used in the financial services sector in London and provides access to Accounting, Financial Market and Economic data. The Accounting data sets give users access to several hundred accounting variables, both cross-sectionally and in time series, for several thousand U.K., U.S., Canadian, Dutch, Japanese, French, and German companies. For example, the Gearing Ratio of each of the 700 (approx.) U.K. companies forming part of the Financial Times All-Share Index could be downloaded to a floppy disk in two or three minutes. The Financial Market data sets contain stock prices, stock market index values, bond prices, interest rates and exchange rates. Option trading data is also available. Exchange rate data is available for about 60 countries. Stock price data is available for companies quoted on stock exchanges in 15 major trading countries, and stock market indices and interest rate data is available for all major trading nations. Most financial data sets are available at a daily level and are normally updated daily. Data can also be collected at a weekly, monthly, quarterly or yearly level. A useful facility available through the commercial communications package is the ability to search the databases to identify companies which meet specified criteria. For example, one can very readily produce a listing of all U.K. companies for which the cash holdings at the last Balance Sheet date are greater than the market capitalisation of the company.

The Economic service consists primarily of access to the OECD database which contains economic series for major trading nations, and the IMF database which contains information in respect of almost every country in the world.

It is also hoped to use the communications and data trapping environment that has been created in order to access other financial databases. A service to which academics might particularly wish to subscribe is REUTERS. This provides trade to trade prices in real time. Access to this service would create, for example, the opportunity to explore the use of trade to trade (rather than close to close) price data in estimating the volatility of returns on financial assets.

TEACHING

We see three ways in which resources of this type can be used in teaching:

1. As a source of illustrative material

The main benefit has been in preparing case studies and illustrative examples, however, access to the financial information networks can be extended into the lecture room by channelling the network link through a projector. In this way, it is possible to bring the financial world directly into the teaching environment, and to observe the events in the market from the lecture room.

2. As a source of raw data accessible by large numbers of students

Online access to financial information provides the means of obtaining a wide variety of financial datasets for tutorial exercises, and students are encouraged to explore modelling procedures on datasets which are downloaded and made available to them on the local mainframe. The availability of on-line information has made the setting up and teaching of quantitative material more interesting and directly applicable to real-life situations.

3. As an interactive resource

The cost of a log-on facility to a financial database means that it is difficult for academic institutions to provide multiple simultaneous log-ons for tutorial groups and interactive access has thus been limited to postgraduate students who are shown how to download and process data during the introductory phase of the Masters programme. Then, as part of their coursework, students are given a number of projects requiring them to access DATASTREAM interactively.

The larger numbers of undergraduate students can use the resources simply as personal computers for the manipulation of locally held data, or as graphics terminals to access the more powerful ststistical and graphical packages that are available on the local mainframe.

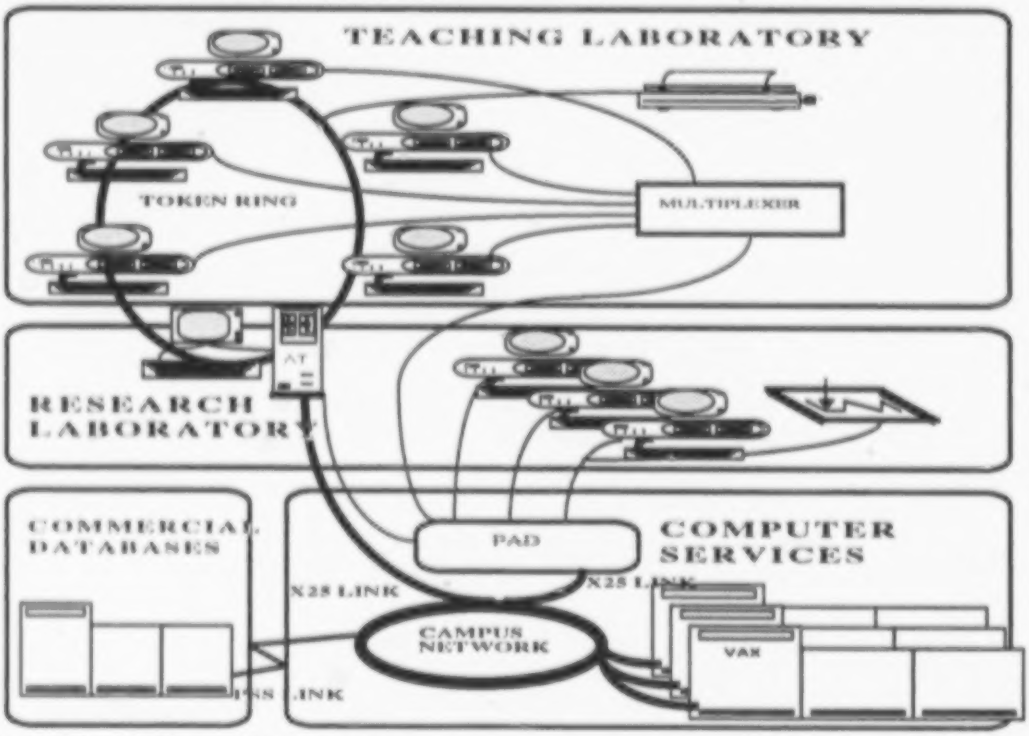


Fig. 1: The Hardware Configuration

REFERENCES

Bux, W. et al., "Architecture and Design of a Reliable Token Ring Network", *IEEE J. Sel. Areas Commun.* **SAC-1.5** (Nov. 1983), pp.756-65

Dhas, C.R. "X25: an Interface to Public Packet Networks", *IEEE Commun.* **24.9** (Sept. 1986), pp. 18-25

ARABIC BY COMPUTER

A.A.Brockett* and O.B.Taylor+

ABSTRACT

Computer assisted Arabic language learning materials for1st year students have been in use in Leeds University since October 1986. Their main purpose so far has been to help students internalise grammar and lexis. Student response has been very positive. On an informal, voluntary, basis students from subsequent years have also been beginning to study more advanced, text-based material on the computer. Factors affecting the successful introduction of such materials can be identified and are discussed in this paper.

INTRODUCTION

The "Arabic by computer" project (or "Abc1" for 1st year students and "Abc2" for subsequent years) has been reported by the authors in several conferences and publications during the last two years. The purpose of this paper is to respond to the interest shown on these occasions about the process of introducing such materials, as well as to describe their content.

THE PROCESS OF INTRODUCING COMPUTER TEACHING MATERIALS

1. **Abc1.** Most teaching institutions already have a planned course and a set of teaching materials. The introduction of computer materials therefore represents either an additional component in the course or the substitution of computer materials for some other learning/teaching process. In either case the decision to go ahead will be based on different considerations from those affecting a new course being designed from scratch. In Leeds University there already was a course, and it is with that type of situation that this paper is concerned.

One stimulus to the introduction of CALL is the shortage of tutor-student contact hours in relation to the need for intensive interactive learning in basic language acquisition. Abc1 programs have been designed to provide back-up practice for students after the grammar or lexis has been introduced in a face-to-face teaching session. They are thus integrated into the process and progress of the existing language course and represent an addition rather than a substitution of learning/teaching materials.

The problem with this process, however, is that while it undoubtedly represents a widely welcomed increase in facilities for the students, it may not represent a saving in time for the tutorial staff - at least in the first year of the project. Indeed the reverse may be the case, for at least two reasons. Firstly, the integration of the CALL materials into the existing course has to be planned, and this is

---

* Dr.A.A.Brockett, lecturer, Dept. of Modern Arabic Studies, University of Leeds

+ Col.O.B.Taylor (Retd), (formerly CO, Army School of Languages), Abc1 programmer time-consuming - for it requires the tutor to be familiar with the materials, so that full advantage can be taken of them. In 1985-6 at Leeds, there was also the very considerable time required to coordinate the initial design of the materials between the tutor and the program writer. Secondly, a tutor may have to be present when the students use the CALL materials, and there is therefore no saving in tutor contact hours. It is arguable, of course, that because each student is working individually, the tutor's time is more efficiently used, but in absolute terms it represents an hour in the tutor's timetable. This problem, however, can be solved if the computers are all linked to a networked hard disk, as all the Arabic programs can be permanently installed and available to anyone whenever the network is open.

Each of the programs used in Abc1 addresses a different aspect of grammar; the order in which students use them can be varied to suit the course structure decided by the tutor. Each program contains a number of different tests, in some cases twenty or more; in order to enable the student to keep track of which tests have been used and the score achieved, a separate file can record the student's name (or personal pseudonym) and the relevant data. A useful addition on a private-study network system would be to provide the option of a paper print-out of this data.

The Leeds Abc1 programs are structured in one of two ways. In some cases they are comprised of a single element, while in others they comprise a "driving" program plus a file of data (for example a file of test sentences, or lists of verbs, or vocabulary items). Single element programs are used where the concept is the dominant consideration, while double element programs are more appropriate to lexical and textual exercises. For example, the concepts underlying the *idaafa* construction (word order, definition and case) can be illustrated, practised and tested using a restricted number of simple lexical items. These items can be incorporated as part of the program, in the expectation that any user would be content to use them as the vehicle for the concept. However, programs which exercise, for example, the conjugation of verbs, or test knowledge of lexis, are more acceptable when they use items which appear in other elements of the course materials. In such cases, it is important to keep the data separate from the "driving" program. The driving program determines the way in which the data is presented, while the files of data, which determine the content, are lists of the items appropriate to a particular course. This is a more complex type of process, because it also requires a separate program to be written for the compilation of the data lists. The double-element program is therefore in reality a triple-element suite, although the student never uses the third element.

At Leeds the compilation of the data lists for the double element programs has been a joint project between the tutor and the programmer. The tutor has decided what he wanted in the course and has written it out on paper, and the programmer has then transferred it into the data files. This mode of operation has enabled the project to progress faster than would otherwise have been the case. If the tutor not only had to design the materials, but also to incorporate them into the computer data files, it obviously would have demanded more of his time. However, it would also have required the program designer to produce much more sophisticated programs for the creation of the data files because they would be used by "non-programmers". This would have taken time which could be used more efficiently for producing more student programs. The design of user-friendly data entry programs is now well advanced, however, and is probably an essential element in a final version of the package. But the use of such programs does raise a new set of questions about the attitude of tutorial staff to computers, and constitutes a further stage of the project's development.

The project has so far demonstrated that the great majority of students who have used the materials consider them useful, stimulating and enjoyable; it has also demonstrated that it needs a tutor who is strongly committed to the experiment, and who will react to teething problems in a positive way - which often means devoting precious time to solving the problems in consultation with the programmer. It remains to be seen whether tutors would have the commitment not only to design their computer materials, but also to create their own data files. There is no doubt that the data-entry programs would have to work in an extremely easy way, and that the written instructions for them would have to be quick and straightforward to understand. If they were not, most busy tutors would probably decide that they could not devote the time to the whole process.

A significant number of the programs takes advantage of the inherently algorithmic nature of Arabic grammar to generate questions for the student from a set of algorithms in the driving program applied to the data in the files. For example, a set of words can be manipulated to produce different sentences: "man, house, big" can be programmmed to produce "The man's big house", "The big man's house" and "The man's house is big", and vowel each one correctly. All the rules necessary can be included to ensure that the sentence is not only grammatically but also orthographically correct (i.e. the form of the letters is changed to reflect their positions in the word). This greatly simplifies the amount of data that has to be included in the associated files, and increases the power of the programs to produce different questions, but it does make it more difficult to ensure that every possible combination of algorithms produces correct Arabic. This has been a reason why it has been advisable for the tutor not only to work through the programs as much as possible before presenting them to the students, but also to monitor the students' use of them. There is a risk that the pre-testing of the programs will not have highlighted some rare combination of the driving algorithms producing an error in the Arabic. Obviously, the more the programs are used the greater the confidence that can be placed in their reliability.

2. **Abc2.** The process of introducing this more advanced material into the teaching of Arabic has so far been informal. This is for three reasons.

Firstly, the program is still only in the "beta-test stage". That is, students are using it on a voluntary basis to comment and suggest improvements, and it is being offered on trial in the same way to other Arabic-teaching institutions. This use of it is being closely monitored and evaluated by questionnaires and discussion. Secondly, a classroom situation requires a network of stations, and our hard-disk has as yet only two linked to it. But thirdly, and most importantly, the best method of using this material may well turn out to be informal. It is for more advanced students, from second year upwards without limit, and is based on a "library" of texts taken from the Arabic Press. Users are invited to "roam" through the bays of the library and look at any text that catches their eye. They may then practice their reading and comprehension skills on a given text in three ways - either by filling gaps created in the texts, or by vocalizing the consonants, or by unscrambling a text that has been disordered. Work is going ahead to make the whole environment more responsive by providing a semi-intelligent glossary to the texts. The Macintosh Plus is being "taught" elements of Arabic grammar in order to be able to provide (at a click of the mouse) sensible answers, prompts and/or questions to an enquiry about a word or usage in a text. It will be able to provide synonyms, antonyms, and will be able to take a user to other texts containing the same word, phrase or topic. A self-cataloguing (or authoring) system will be devised enabling anyone to place new texts into the library. These texts will automatically both become available for manipulation by the exercises and the tests, and have their vocabulary incorporated into the storehouse.

Thus Abc2 is multi-level and will steadily become more so. Users set their own level of difficulty by choice of text, and, for instance in the gap-filling exercise, by choice of quantity of gaps to be created and whether the text is to be vowelled or not. Elementary students tend to need more outside direction, but more advanced ones may well prefer the freedom to roam at their own will. It is thus more like private study than classroom testing. There is for sure a scoring system built in to the exercises, but it is not stored for cumulative assessment. It is designed simply to let users know how well they did that particular exercise. If they like to keep a record of thrie marks then they must do so on paper. Furthermore, informality can still pertain in a classroom setting. Several users learning Arabic for special purposes can be working at the same time but in completely different subject areas. A diplomat could brushing up her/his reading knowledge of reports about state visits, a businessman or woman may want to concentrate on the vocabulary and phraseology of Middle Eastern export/import markets, and someone from the Army may be interested in the terminology of the Gulf War.

Nevertheless, if desired, a more formal use could very easily be set up. A tutor of modern or classical literature, for instance, could input a defined corpus of texts that the students were to be examined on at the end of the course. Then for any given class the students could be told, "today you must work on such and such a text, before you begin let me give a brief introduction ..."

Although exposure of Abc2 to users is still at a very early stage, there has been an excellent response. All the students at Leeds who have used it have been enthusiastic. They have all enjoyed the exercises and have found the Macintosh simple to use and the Arabic script easy to read. Distinct interest has also been shown in the USA, where they are not so well advanced in this field.

TOWARDS AN EVALUATION OF THE USE OF INFORMATION TECHNOLOGY IN CURRICULUM DEVELOPMENT WORK

MARGARETTE LINCOLN*

ABSTRACT

The Further Education Unit (FEU) has carried out a project to evaluate the potential benefits of using information technology (IT) to support the processes of curriculum developoment. The project team produced a monitoring framework to enable the discrete benefits to be assessed. Demonstrator projects were set up within colleges and a survey of colleges and some training establishments was carried out in order to discover the current use of IT systems in this context. The results of this project indicate that the potential benefits of introducing such an IT support system justify both the initial effort required and any maintenance of the system. FEU anticipates that the monitoring framework used in this project will be transferable to other IT-related projects.

INTRODUCTION

The aims of this session are:

(i) to describe an FEU project, funded by the MSC, which investigated the use of information technology to support the processes of curriculum development;

(ii) to outline the monitoring framework that was produced to record and evaluate the demonstrator projects set up within the main project;

(iii) to describe the outcomes of the project and (as time permits), to discuss the appropriateness of the monitoring framework, and the degree to which it might be used to judge the potential of similar projects involving IT.

BACKGROUND TO THE PROJECT

Tutors in further and higher education are increasingly involved in curriculum development. This is due to a number of factors: the trend towards modularisation of courses, the pressure to integrate information technology into the curriculum, and the need to accomodate education and training to rapid social and economic change.

Those undertaking curriculum development have always required support. Traditionally this support has taken the form of secretarial, librarian

*The Further Education Unit, Elizabeth House, York Road, London SE1 7PH.

and technical support. In this project we set out to investigate the potential of IT to provide distinctive support systems. We intended that the project would itself encourage the use of IT support systems by involving a number of colleges who would undertake the demonstrator projects. We also planned a detailed dissemination programme as a follow-up project. With this in mind, we were careful to evaluate the potential benefits of IT support systems and to record any problems associated with their use.

PHASE 1

In the initial stages of the project, we produced an overview of IT-related work in this area. Several expert consultants were invited to contribute, and the outcome was a published report describing the IT systems available and their use as tools to support curriculum development.

The FEU uses a familiar model of curriculum development, derived from both education and training theory. It includes the processes of assessment of values and needs, course design, implementation, evaluation and review. The matrix given in Figure 1 illustrates the potential interaction between these processes of curriculum development and the various IT systems that can provide support.

PROCESSES OF CURRICULUM DEVELOPMENT	INFORMATION TECHNOLOGY SYSTEMS				
	INFORMATION NETWORKS	INFORMATION CENTRES	COMPUTER-ASSISTED LEARNING	INFORMATION PROCESSING	IMAGE PROCESSING
VALUES AND NEEDS					
DESIGN					
IMPLEMENTATION					
EVALUATION AND REVIEW					

Figure 1

For instance, information networks (e.g. computer conferencing) can be used to obtain expert advice when designing courses; computer-assisted learning packages can be used to help implement a course; information processing systems can be used to analyse and present the results of an evaluation.

PHASE 2

In Phase 2 we set up a number of demonstrator projects in colleges. We aimed to cover as many areas of the matrix as possible but limited time and funding meant that some gaps were inevitable. To fill these gaps we carried out a survey of colleges in England and Wales, and also contacted training establishments, in order to obtain information about related project work that could be evaluated in the same way as the demonstrator projects.

THE MONITORING FRAMEWORK

It was essential to monitor closely both the demonstrator projects and the related work in order to identify the benefits or shortcomings using IT in this context. An immediate problem was the construction of a framework for the monitoring of a number of projects covering a broad range of applications. There are fields outside education and training where systems are designed and applied (often loosely), and the effects of such systems have been evaluated. Examples of such monitoring are to be found in engineering and commerce. Although these monitoring systems may be tentative, for the purposes of the project we decided to build on such approaches and to introduce modifications where necessary. The approach we adopted is based on a method of assessing the benefits of a software information system (ref 1).

FEU's monitoring framework comprises a list of benefits that may accrue from the use of IT in this context. These benefits include:

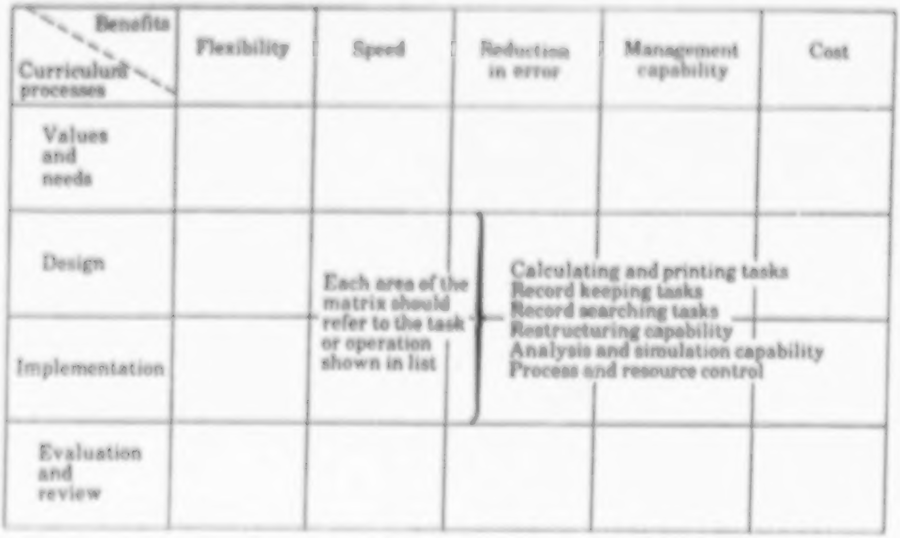
- error reduction;
- increased flexibility;
- increased speed;
- increased management capability;
- cost reduction.

Direct benefits may be obtained in such areas as:

(i) calculating and printing tasks;
(ii) record-keeping and record searching tasks;
(iii) analysis and simulation capability;
(iv) process and resource control.

Indirect effects to be taken into account include: the teacher's previous experience of IT, student attitude to the use of IT in the implementation of the curriculum, and the impact of the use of IT on the institution.

The possible benefits of using IT systems in curriculum development are shown in Figure 2.



Benefits / Curriculum processes	Flexibility	Speed	Reduction in error	Management capability	Cost
Values and needs					
Design		Each area of the matrix should refer to the task or operation shown in list	Calculating and printing tasks Record keeping tasks Record searching tasks Restructuring capability Analysis and simulation capability Process and resource control		
Implementation					
Evaluation and review					

Figure 2

FINDINGS OF THE PROJECT

Some of the project outcomes could have been predicted; others give altogether new insights into the use of IT in curriculum development work. The principal findings were:

- strong management support and commitment is crucial to the success of an IT support system;
- IT systems act as a catalyst to curriculum development;
- there is a steep learning curve with respect to IT systems and this leads to a temporary drop in an institution's productivity when IT is introduced;
- the most successful demonstrator projects were curriculum-led rather than technology-led, and also clearly defined and comparatively unambitious;
- technical support is a vital factor;
- adequate software tools are not always available to curriculum developers, but once a need is perceived and expressed, software houses are anxious to develop suitable programs;
- once the decision to use IT has been taken, subsequent use sparks off other ideas for the implementation of IT in curriculum development;
- the initial capital expenditure required is substantial but IT can be cost-effective over a period.

Perhaps the most significant outcome was that we were able to develop a monitoring framework for the detailed evaluation of the use of IT in curriculum development work.

1. See King & Schreims, ACM Computing Surveys, Vol. 10, No. 1, 19-34 (1978)

071

Computers in Third World Schools

Debugging the Wrong Approach to Make it Right for the 1990s

* S Kirmani and M H Kirmani

ABSTRACT

This paper is in two sections. The first section will discuss some of the critical problems in introducing computers in schools in developing countries like Pakistan and Kenya. Some of these problems may be classified under areas such as:

- educational policies of computer implementation
- accessibility to technological resources
- availability of technological personnel
- development of teacher training programs
- cost effectiveness

The second section of the paper will provide suggestions for novel ways in 1990's to broaden thè base of computer resources with a view to addressing some of the issues raised in the earlier section of the paper.

* * * * *

---

* Somerville, MA, UNITED STATES

072

TUTORING STRATEGIES AND KNOWLEDGE ENGINEERING IN A WIDE DOMAIN

Ted Fuller* and Andy Slade+

Knowledge-based tutoring systems are constrained by available technology in the way they replicate "human" approaches. When the knowledge domain is wide the problem becomes greater. A recent development by Durham University for tutoring/guiding owner entrepreneurs in profit improvement faced these problems.

Meaningful tutoring of owner entrepreneurs requires the use of their own business as a model, because their objective is business improvement, not merely increased personal competence. Each business has its own individual context. Human tutors/counsellors normally use open discussion as the main means of obtaining basic information upon which to build their tutoring.

The tutoring strategy necessarily adopted by the Durham KBS limits the range of responses possible while at the same time keeping the user informed and motivated. This requires the development of a wide range of contingent situations and linkages between these and a fundamental business model. It also requires the encapsulation of practical advice which is offered in a style acceptable to a "self sufficient" entrepreneur.

This paper outlines the tutoring strategies used and the implications these have on the approach to knowledge engineering.

The strategy adopted by the KBS is essentially that of a counsellor. The reasons for this choice are to include the objectives of the system and at the same time explore the limitations to viable knowledge engineering. Further discussion of this choice of approach is outside the scope of this paper.

A counselling strategy aims to provide the client with a clear picture of the situation they face by feeding back their responses in a structured form. This means that the system must be relevant to each individual user, not prescriptive but allowing the user to draw conclusions from the feedback provided.

The strategy outlined is directed towards satisfying a set of goals or objectives which should provide a framework for a successful tutoring system. These objectives include;

*Ted Fuller, Durham University Business School

+Andrew Slade, Department of Computer Science,
Durham University

The encouragement of trust and belief in the system.
To motivate the user sufficiently so as to cause him/her to continue to use the system and to take notice of it.
To cause the user to recognise the need for the advice given by the system.

To provide advice that can be understood by the user.

None of these objectives is very radical, in fact they are probably viewed better as a set of requirements for a good tutoring system. The importance of stating them in the context of this discussion, however, is that achieving these objectives with a human tutor is one problem; but achieving them with an expert system is another, much harder, one.

The tutoring strategy used addresses these objectives at several different levels including the fundamental one of communicating with the user in a meaningful fashion and the somewhat more esoteric one of obtaining the information from the experts in such a way as to be able to provide the needed advice in as efficient a manner as possible.

One of the key problems any tutoring system faces is that of encouraging the user to develop a sense of trust and belief in the system. Trust and belief will be enhanced if they system reflects the values of the user. This implies that the language and style of the system and the way in which the evidence is interpreted should be such that the user can readily identify with them. This identification will be easier to achieve if the explanations offered by the system do not simply echo the logical structure of the stock information, but stem from the value model inherent in the structure of the system and its responses.

The inherent values and the logical structure of the system combine to form the information against which the user's evidence is assessed. In the course of this assessment parts of the logical structure of the domain knowledge are explained to the user in the form of rules governing the dynamic behaviour of the particular domain. These explanations form an important part of the total output of the system. As well as the logical explanations there are a large number of examples which serve to reinforce the implied values of the system and which aid the user to appreciate the reasoning behind the logical structures. The dynamic behaviour of the system is represented by a cause-effect structure and is presented with the user's evidence as justification for the system's behaviour. Making the relationship between the evidence and the cause-effect structure clear will provide the user with an explanation of why the system is asking a particular question at a particular time.

The implications for knowledge engineering are that the experts who contribute to the system must have empathy with the target users, in order that they can appreciate the effect of the advice offered and also the effect of the style and language used. The construction of suitable explanations is also an extremely important task. The difficulty with eliciting this knowledge is that the experts use a mixture of techniques to explain themselves but we have to distinguish between points related to the logical structure and those related to heuristics. The importance of separating knowledge in this way is addressed later in the paper.

The second objective, that of motivation, is tackled partly by the strategy of providing continual feedback on where the analysis has reached and providing advice within the frame of reference of the user, and partly by controlling the level and gradient of the questions.

Any consideration of the appropriate feedback mechanism for a system such as the Durham KBS has to include things like, how much text to put on the screen at one go? There has been a great deal of work done on the question of human-computer dialogues but, for our purposes, we used our experts to construct and vet the presentations to the user, so as to provide a style that we felt they would be comfortable with. We used two types of expert for this phase, counsellors with a great deal of experience in differing styles of dialogue and small business owners who provided extra feedback on the presentation style and strategy.

The problem for knowledge elicitation is to integrate the various views on how to present information without adopting a lowest common denominator approach. This was partially resolved by deciding to give more weight to the views of the expert counsellors but using the other views as a way of adjusting the perceived value of the advice offered.

The third objective of the system is to help the user recognise that there may be a problem with their own approach to small business management. This objective is hard to achieve in practise for obvious reasons, but it is essential that if the system detects potential problem areas, then the user must be encouraged to recognise these and to do something about them. One way of achieving this is for the system to analyse the data provided by the user. This will necessarily entail the entering of factual, numerical, data about the user's business, but analyses of this type are valuable in that they provide a strong link between the user's knowledge of his business and the system's understanding of the major financial indicators.

The examples and explanations given to the users reflects strongly the value system inherent in the KBS. This provides a basis for comparisons between the user's view of the state of his/her firm and the view the system has of it. Two approaches to the comparison are used. One being to give the user advice like, "most firms in this position would do ....." and the other is to allow the user to decide themselves, from a menu, whith advice to follow. The implication of this choice would then be analysed using the model, heuristics and the evidence. The two approaches can be viewed as normative and non-normative, respectively. Both have implications for knowledge elicitation.

In order to provide useful feedback to the user on the reasoning behind the question strategy, it was found to be advantageous if the knowledge elicited was viewed as consisting of distinct types, rather than all one. The knowledge was divided into a structure which represented the "rules" of the domain, the textbook knowledge, and another, separate, body of knowledge which represents the heuristics, or rules of thumb, associated with the domain. This approach was used by Swartout in an expert system for a medical problem. The division provides us with a way of explaining how we arrived at a particular question and also to summarise the results and conclusions reached so far in the consultation. This type of approach fits in with good counselling practise, pointing out to the user the consequences of the answers given so far, but in the context of the rules of the domain.

This paper has presented the basic strategies employed in the Durham KBS and has analysed the effect on knowledge elicitation. The study shows that fine discussion of the knowledge is needed in order to satisfy the objectives of the system. To provide clear guidance and assistance, the system has to make explicit both the textbook rules of the domain and the heuristics associated with it.

The use of many different types of expert and the integration of their knowledge of differing aspects of the domain has proved to be a formidable task. Further work is needed on the manner in which the integration should be done.

AUTOMATING THE TEACHING OF INTERVIEWING SKILLS

*BARKER P., MITRA R., WOODHOUSE D.

ABSTRACT

This paper outlines research that aims to develop an expert system which can be adapted for use as a computer assisted learning aid to teach interviewing skills. Current research in the field of human-computer interaction has shown that it is possible for computers to emulate certain characteristics of human conversational skills. By combining advanced methods of human-computer interaction with the appropriate knowledge engineering and elicitation techniques it is possible to construct an 'intelligent' CAL system. Such as system would be capable of performing a dual role with respect to the interview process. That is, it is able to play the role of either interviewer or interviewee using interview scenarios that are specified by its client population. This paper explores these possibilities by describing the basic design of such a system. It also outlines the nature of the initial research undertaken to date - with particular reference to the knowledge elicitation techniques involved in obtaining the heuristics of the expert interviewer.

INTRODUCTION

One of the major aims of the human communication process is to facilitate the transfer of knowledge and information. Within this process participants can be said to share various attributes; for example, representation (similar language capabilities and underlying thought mechanisms), knowledge (about social norms of behaviour, the subject of communication and each other's background), and adaptability (modification of the interaction to take into account past and present interactions).

Prior research in the area of the social psychology of human communication indicates that the motiviation for such interaction stems from both tasks and social goals. If this communication is to be effective then participants should have a shared world perspective; that is, an understanding of the mutual goals - both task and social - and the ability to direct the process to meet the demands of these goals. Thus participants need to have some sort of model for encoding and receiving information. The sender needs an

*Teesside Polytechnic, Cleveland, TS1 3BA, United Kingdom

internal model of the state of the receiver in order to design the message, and the receiver can only interpret the message in the context of a model of the state of the sender.

INTERVIEW PROCESSES

Basically, an interview can be regarded as an interaction between two, or more, people that takes place in a given context in which the aims are: (1) to facilitate communication, and (2) to obtain information.

Initially, in the interview situation it is postulated that there are five important entities: the interview, a brief (context), a set of cognitive working models, a knowledge network, and an interviewee. That humans develop cognitive models to handle complex situations is well established. Therefore, in an interview situation the nature of the basic models involved needs to be determined. In such situations it is believed that the inter-viewer builds up a set of cognitive models as a result of (a) the information contained in the brief and (b) dynamic interaction with the interviewee. The role of the brief is essentially one of specification. That is, it indicates what is to be derived from the interview. As a result of assimilating the brief, the interviewer constructs a mental (possibly partially exteriorised) model set.

The knowledge network defined by this model is inherently vague at this stage. It contains many knowledge/information gaps that need to be filled in. The order in which the 'emptiness' of the knowledge network is removed may be influenced by priorities specified by the brief, the skills/preferences of the interviewer, the type of interview, and the characteristics of the interviewee. Because interviewing is essentially highly interactive in nature, information flow is not unidirectional. Just as the interviewer builds mental model sets, the interviewee reacts in a similar way by constructing working models of order to handle the situation. Obviously, the progress and effectiveness of an interview will, therefore, be significantly influenced by the behaviour of each of the participants. Furthermore, the information that each derives from the interview dialogue is likely to be strongly coloured by role playing paradigms - particularly the extent to which participants 'act out' their parts.

WORK TO DATE

From the above discussion, it is obvious that many complex cognitive and behavioural process take place in an interview situation. Given the diverse situations in which interviews are used it may well be difficult to generalise about the human processes involved for it is often a question of degree and context. For example, the market research interview does not have the same degree of psychological input as the psychiatric interview. But there are some common denominators. There is a plethora of research into the basic skills involved in interviewing eg question wording, attending behaviour etc. But there is less investigation into the heuristics involved in the application of these skills.

Work is now underway to create an expert system that can be adapted for use as CAL aid in the teaching of interviewing skills. Particular emphasis is being given to selection interviewing due to the degree of structure involved in this type of interview process. The system is being designed to perform a dual role. Essentially these are: (1) to act as an expert system (emulating the behaviour of an 'expert' interviewer) to interview applicants in a selection situation. This means that the rules, heuristics and strategies used by the expert interviewer will constitute the elicited knowledge and will form one part of the knowledge base. Another part of the knowledge base will be 'client' profiles; (2) to act as an intelligent tutoring system to train 'novice' interviewers in 'expert' skills and strategies for decision making within the selection interview situation. The system will also have the facility to create 'models' of the 'novices', map out their learning behaviour and monitor their progress according to their responses given in the tutoring session.

SYSTEM ARCHITECTURE

The basic architecture of the interviewing system that we are constructing is illustrated schematically in Figure 1. The various roles that the system is able to undertake are represented by the boxes on the right-hand side of the diagram. Each function is supported by a combination of interactive dialogue programs that are responsible for conversing with their respective user groups. Essentially, the system can undertake either of two instructional roles - functioning either as an interviewer or as an interviewee. The information and data that are needed to act out each of these roles is specified by members of the client population prior to its use by other groups of users. These specifications may take the form of either verbal or written interview briefs and scenarios. These are subsequently coded into appropriate data structures (such as plans and scripts) through the use of an Interview Specification Language (ISL). The scripts and plans are used in conjuction with suitably designed knowledge networks in order to store the information obtained during an interview and (through the pre-knowledge that they might already embed) guide the progress of the interview process. Fundamental to the adequate provision of the client support

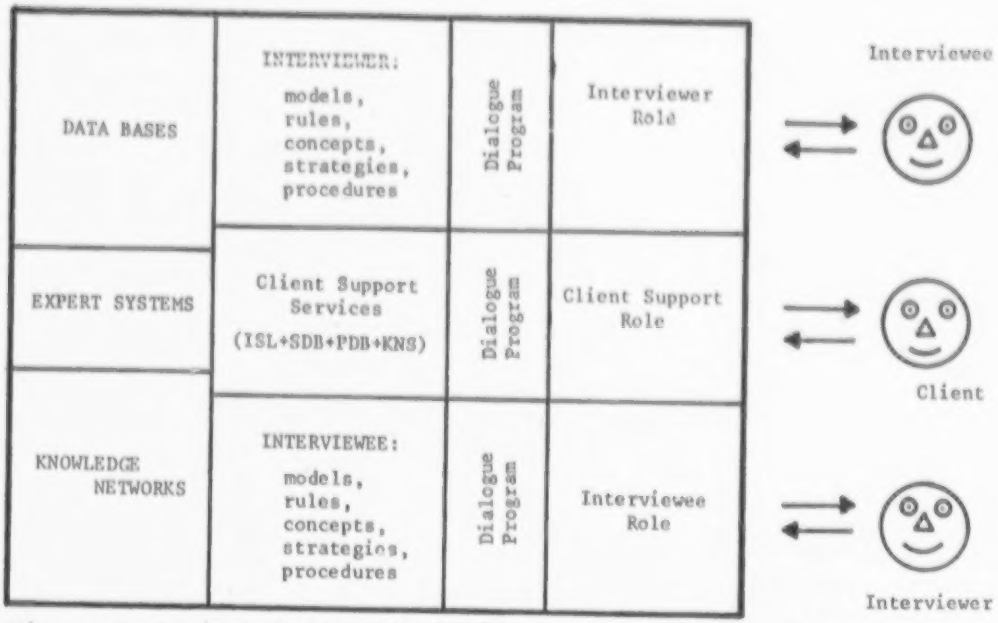

DATA BASES
EXPERT SYSTEMS
KNOWLEDGE NETWORKS
INTERVIEWER:
models,
rules,
concepts,
strategies,
procedures
Client Support Services
(ISL+SDB+PDB+KNS)
INTERVIEWEE:
models,
rules,
concepts,
strategies,
procedures
Dialogue Program
Dialogue Program
Dialogue Program
Interviewer Role
Client Support Role
Interviewee Role
Interviewee
Client
Interviewer

Figure 1. Basic building blocks for an interviewing system.

services depicted in Figure 1 is the use of an appropriate data base management facility. This provides a variety of system management functions for the scripts data base (SDB), the plans data base (PDS) and the knowledge network systems (KNS) upon which the overall operation of the system depends.

KNOWLEDGE ENGINEERING TECHNIQUES

The interview can be viewed as consisting of three general phases: (1) a prologue; (2) a body; and (3) an epilogue. A variety of different models, rules, concepts and procedures will need to be established in order to support the operation of each of these phases and, of course, the overall way in which the interview is conducted. As has been suggested earlier, much of our initial research has been orientated towards the identification and specification of these parameters. Their representation within the interviewing system will, of course, require substantial research and development effort. Currently, we are exploring the suitability of various types of expert system facility for codyifying the knowledge and skills that we have elicited from a number of sources: discussions with interviewers and interviewees; the detailed analysis of video taped recordings of interviews; and the application of Kelly's Personal Construct Theory via the use of REPGRID - a computer package that is based upon Kelly's ideas and allows elicitation of contructs relevant to the knowledge domain in question. Of the different types of expert system architecture that we have examined a system based on the use of frames has been selected for our initial investigations.

TRAINING PRIMARY SCHOOL TEACHERS TO USE COMPUTERS EFFECTIVELY IN THE CLASSROOM - AN INVESTIGATION INTO INSERVICE PROVISION

M.J. Cox and V.J. Rhodes*

ABSTRACT

Case study investigations were carried out in twelve ILEA primary schools (1/85-7/87) with headteacher and teacher interviews and classroom observations. The researchers also observed inservice training courses and interviewed the course teachers and INSET tutors, to enable the teacher training activities to be related to the actual classroom practice. The results show that some tutors perception of training needs as reflected in short courses may differ from the actual training needs identified through teacher interviews and classroom observations. Many of the teachers interviewed felt that the training they received on a short course had not been enough to help them incorporate computers into the curriculum. This paper will present some of the research findings relating to the short courses, and will discuss ways in which short inservice courses can be designed to reflect teachers' training needs more closely.

INTRODUCTION

The successful implementation of computer assisted learning (CAL) at a school level necessitates an adequate and substantial level of teacher training. However the majority of the present teacher population has had no pre-service training in the new technologies, and often only a two day course as required by schools participating in the Department of Trade and Industry's 'Micros in Primary Schools' scheme (ref 1).

In order to investigate the uptake of microcomputers and the impact of inservice training, research was carried out in twelve primary schools and eight INSET courses in the Inner London Education Authority (ILEA). ILEA has over seven hundred and fifty primary schools and a unified policy for curriculum development. A study undertaken in such a large education authority will have implications for policy makers nationally and internationally.

METHODOLOGY

In 1985 a small number of ILEA primary schools was selected for case study investigation. Details of the sample and of the method of data collection are described elsewhere (ref 2). As a result of this study and of earlier work which has been reported by other researchers (ref 3), it was clear that there was a need for some in depth investigation into the content of inservice provision available to primary school teachers. The project decided to carry out a series of observations of INSET courses available throughout the Authority. This work began in 1986 and

---

*Educational Computing Unit, Centre for Educational Studies, King's College London, 552 Kings Road, London SW10 OUA.
This research was funded by the Inner London Education Authority, the Economic and Social Research Council and Research Machines Ltd.

is still in progress.

The researchers acting as participant observers attended eight different INSET courses, details of which are given in Table 1. Tutors and course teachers were interviewed using semi-structured interview schedules. Data collected included the background of teachers, their expectations and evaluation of the INSET provided, the role of the tutor and the content and value of the course. Based on the observations a number of factors were identified which were used to categorize the training. The objective of this phase of the study was to assess the training needs of teachers as perceived by course tutors and the course teachers, and as reflected in the INSET provided.

Table 1 - Characteristics of the INSET courses studied

Course Number	Time		Venue				Written Assignments		Award Bearing		Length in Hours
	Short	Long	School	Teachers' Centre	College	ILEA Centre	Yes	No	Yes	No	
1	✓			✓				✓		✓	8
2	✓			✓				✓		✓	9
3	✓			✓				✓		✓	12
4	✓			✓				✓		✓	6
5		✓			✓		✓		✓		150
6	✓					✓		✓		✓	3.5
7	✓		✓					✓		✓	3
8	✓		✓					✓		✓	*

* Incomplete data

The ILEA has a comprehensive programme of long courses (no.5), which are still being evaluated. This INSET is supplemented by short courses at different Teachers' Centres.

This paper presents some of the findings from the classroom observations, teacher interviews and only the short course observations and interviews.

CONTENT OF THE SHORT INSET COURSES (6-12 hours)

One of the aims of the beginners short courses studied was to give teachers sufficient competence and confidence to enable them to start using computers in their teaching. Course members were introduced to a range of open-ended software which could be used across the curriculum.

The effect of a short course which emphasizes open-ended software, which is complex to operate is that:

a) tutors have to spend a large proportion of the time instructing teachers simply how to operate the software, and
b) teachers have to assimilate a large amount of information in a relatively short time. The time spent on these activities is shown in Table 2.

Table 2 - Percemtage (%) of time spent on different activitiies in open ended software sessions

Course Number	Word Processing			LOGO			DEVTRAY			Information Retrieval			Wordsmatics			Viewdata		
	I(%)	U(%)	E	I(%)	U(%)	E	I(%)	U(%)	E	I(%)	U(%)	E	I(%)	U(%)	E	I(%)	U(%)	E
1	50	50	M	51	‹47	L	27	62	S	-			-	-	-	-	-	-
2	*	*	-	47	!53	L	*	*	-	56	46	L	-	-	-	-	-	-
3	0	83	M	22	‹67	L	34	46	S	53 23	43 37	M M	28	69	M	55	23	M

* data not available
; program introduced over two sessions

I - Instruction by tutorrs on software operation
U - Teachers using the seoftware
E - Extent of reference to educational issues

M - Minimal
L - Some
S - Substantial

Many teachers found the courses enjoyable but at least 7 teachers (out of 26) said that they had been unable to absorb all the facts and felt that they needed more training at the same level before they could confidently start to use a computer in the classroom.

'I found it (the course) too technical for beginners and too much information for beginners'.
'I could do with doing things all again because it's difficult to take it all in'.
'After the course I need to go on lots more courses, I need about three courses'.

TEACHER INTERVIEWS

Teachers on the short courses were rarely shown the potential of the software for their own class teaching. Teachers who completed short courses still were often unsure of how to implement the use of computers into the classroom. Teachers said, for example:

'(I'm) not sure how best to introduce it to the children'.
'I need another course, which showed us how best to use it in the classroom'.
'I want ideas of how people use programs in schools'.

Little instruction on setting up the equipment or on training teachers in identifying or solving running problems was given on the courses. This was later reflected in the teachers' comments:

'I need to know how to plug it in'.
'I can't imagine (you) would know from a short course what would happen if you got stuck'.

The research showed that not knowing how to set up the equipment can be a barrier to the uptake of the resource, for many teachers.

EFFECTIVENESS OF INSET ON CLASSROOM PRACTICE

Some teachers interviewed in the schools never used computers, although they had attended short courses. They said that the training was too short and the software too complex to be covered in such a limited amount of time.

'I would like to be able to go on a course and learn more at a slower rate'.
'Some programs I found to be difficult'.

Several teachers who used computers regularly in the classroom expressed a need for additional training to help them use computers more effectively in their teaching.

'I could do with more help for applications (of the software)'.
'I don't know where it fits into education'.
'It would be nice to know how to use a program to its full advantage'.
'(The computer is) still viewed very much as a toy, I don't feel we're using them constructively as a whole'.

Evidence from the classroom observations, for example, using word processing programs indicated that many teachers were unsure of how to use open-ended software to its best advantage. Most children were observed to use the edit facility to correct spelling or punctuation errors, not to develop their creative writing as described by Chandler (Ref 4) and many others. Only one teacher was seen to discuss and review the first draft of work with the pupils with the objective of improving the quality of the childrens' initial effort.

CONCLUSION

The results indicate that the widely held belief, that short courses alone are sufficient training for teachers to use computers in the classroom is not true. Short introductory courses for teachers, with no previous experience, cannot easily achieve the objective of training teachers to use a number of open-ended programs across the curriculum, because many teachers cannot absorb too much complex information in a short time. INSET courses, however short, need to maintain an appropriate balance between instructional software operation (I), teachers using the software (U), and learning the educational uses in the curriculum (E), with adequate emphasis on E. Evidence from the classroom observations confirmed that teachers were often unaware of the educational potential of the open-ended programs they were using. ILEA's policy of long course provision is helping to overcome some of the problems identified in the short courses.

Apart from the inservice training factors identified here, there are many other inservice and school factors which influence the uptake of computers by primary school teachers. These are being investigated by the project and will be reported in later papers.

REFERENCES

1 R. Fothergill, Microelectronics Education Programme (DES 1981).
2 M. Cox, V. Rhodes, J. Hall, Comps and Ed (in press).
3 M.J. Cox, V.J. Rhodes, ESRC ITE Report (in press).
4 D. Chandler, Young Learners and the Microcomputer (OU Press, 1981) p.35.

Retraining Teachers in Low Demand Disciplines as Computer Learning Teachers

Gary G. Bitter, Ph.D. and Richard Sheets

Introduction

Teachers of computing skills are in high demand as computer technology continues to infiltrate modern society and increasingly becomes an important part of our service-oriented economy. Conversely, many highly skilled and experienced teachers across the country in low demand disciplines such as Physical Education, Home Economics and Fine Arts are being laid off (referred to as Reduction in Force, RIF, in this paper) due to declining enrollments. Many of these teachers may be unable to find work in other school districts in their present disciplines due to a glut of teachers available in their fields with less experience and therefore lower salary expectations. This represents a substantial loss to our society and educational system of years of hard-earned pedagogical experience and skills.

In recognition of the critical shortage of qualified computer learning teachers, The Arizona State University College of Education, in conjunction with the Phoenix Union High School District, and funding from the Education For Economic Security Act developed and field tested a model for retraining classroom teachers of other disciplines to become teachers of computer learning.

Objectives of Project

1.0 To increase the retention of experienced teachers in the teaching profession by retraining them into a high demand discipline, computer learning, from low demand disciplines.
2.0 To increase the available reserve of teachers of computer learning.
3.0 To attract qualified teachers and give them an incentive to retrain rather than leave the profession by paying for all course tuition and a stipend upon completion of all courses and project requirements.
4.0 To develop a model program that can be used to retrain teachers in other disciplines into high demand disciplines like mathematics, science, and computer learning in cooperation with local school districts.

Selection of Participants

The retraining project selected thirty-two participants to enter the training. The selection process was based on the teacher having previously been involved and the likelihood of the teacher to continue to be involved in a Reduction in Force (RIF). Twenty-five of the participants were funded through the grant while eight paid their own expenses with the agreement that they would have the option to replace any of the original twenty-five who withdrew from the program. The eight were rank ordered by qualifications for replacement. The project retrained twenty teachers from the Phoenix Union High School District, a declining enrollment district that has experienced several Reduction in Forces of experienced personnel in low demand disciplines, and five teachers "at large" from other local public and private schools, to teach computer learning. The participants were elementary and secondary teachers. These included five special education teachers, two band teachers, two physical education teachers, six English teachers, three home economic teachers, five business teachers, three math teachers, one science teacher, two industrial arts teachers, two foreign language teachers, and one social studies teacher.

Academic Retraining

The students enrolled at Arizona State University in a three semester hour Computer Literacy and Applications course and a three semester hour Computer Programming course during the Fall of 1985. In the Spring semester the participants enrolled in a three semester hour Introduction to Data Processing course and a three semester hour Introduction to Pascal class. The final course offered for the participants was held in the summer of 1986 and was a three semester hour Intermediate Pascal course. In addition, all students were required to participate in fifty hours of internship. This internship included attending conferences, participating in training sessions, assisting in teaching computer classes or individually helping teachers in using computers.

Computer Equipment

Each participant was provided an Apple IIc with a color monitor and printer by the Apple Computer Corporation. This convenience allowed each participant to do assignments at home as well as try out ideas in their classes. In addition, each student was provided AppleWorks, Pascal, Apple Logo and all necessary DOS and BASIC software.

Final Results

The project was completed by nineteen teachers who each received a $600 stipend. Several of these teachers are now teaching computer classes but most have expanded their role as a classroom teacher to include computer usage. Three of the teachers were RIF'd but found computer related positions in other school districts. All teachers were rehired or found computer education positions outside of their school districts. An extensive follow-up of all participants will be done in June 1987.

Conclusions

The participants were intensely prepared to utilize computers in education. The project was highly successful in obtaining jobs for all participants who completed the project and several are now employed as full-time computer education instructors while most of the others are utilizing computers extensively in their regular instruction. The project has shown that experienced teachers in low demand disciplines can be retrained into a new academic discipline through an intensive academic program with financial incentives and continue to be valuable members of the educational community.

QUENCHING THE THIRST FOR TEACHER EDUCATION: HOW, WHEN, AND WHERE TO INCORPORATE SOFTWARE

K.M. Hurley, N.B. Fones, A.V. Kenyon

ABSTRACT

Learning must evolve around the skills we want students to master, not just the content that is easiest to teach or most fun to learn. Just because a particular piece of software is addictive does not mean it should become an entire unit of study, in and of itself. What is fun may, or may not, relate to outcome. As teachers and parents, our charge is to meet student needs, abilities, and interests on an instructional fifty-yard line with our creativity, our talent, our manipulatives and print material, and our software. This match will be discussed as integration of software within specific lessons and among general classroom activities.

INTEGRATING SOFTWARE IN LESSONS

Under Secretary Bennett's direction, the U.S. Department of Education culled over 40 key research findings that have bearing on educational practices. One finding: students learn more when teachers explain and demonstrate the steps to accomplish a task.

Such research endorses direct instruction, in which teachers conduct classroom lessons by following specific steps such as setting goals, sequencing instruction, giving explanations, showing illustrations, asking questions, and providing practice (U.S. Department of Education, 1985, p. 35).

Doug Carnine showed computers and direct instruction to be a powerful combination to boost achievement, attendance, and the likelihood of graduation from school (1984, p. 77). Computers hold great promise for making instruction more direct because software can be found to parallel specific activities within a lesson. One software selection might show illustrations while another piece could provide practice on a topic or skill.

All too often, however, a catchy piece of software becomes an entire lesson, or is used as an unrelated reward for completing a given lesson. Software often supplants rather than supplements teaching because of software overchoice, time constraints, and lack of available training. The training that does occur should make one point crystal clear: software selection and use can, and should be driven by the established curriculum, and not visa versa, which is all too often the case.

Software can be considered "curriculum-based" given it purposefully and systematically matches instructional objectives--academic and/or social. The most flexible and resilient software simultaneously reinforces a cluster of related skills, across subject areas.

Mindscape Software, Inc.
3444 Dundee Road
Northbrook, Illinois 60062 USA
312-480-7667

Software did not always pass this interdisciplinary test. In the not so distant past, many software selections were oriented to single concepts. One disk would only teach the difference between fact and opinion, for example. Such narrow programs tended to be superficial and of limited interest or benefit to students. In response to educator demands, software publishers are now designing broader-based, multi-skill curriculum packages that might reinforce sequencing, deducing, and writing---all at once.

Students process information at different rates, and with different styles. The more flexibility provided by a piece of software, the more use it will gain with a wide range of students. For example, a crossword puzzle maker could be used as part of an ice breaker activity for mentally retarded students simply by keeping the words simple and the concepts basic. For these students, the teacher might design and set up the puzzle on the computer. For faster learners, a crossword puzzle might be used to culminate, rather than introduce a lesson; and this time, the students themselves might be capable of independently creating the puzzle.

Students who can solve story problems in math class by using a ruler might not be able to use that same ruler to measure a piece of wood in industrial arts class. Time, distance, and competing priorities negate transfer. Transfer of learning from one situation to another, however, is not easy. In addition to subject matter content and basic academic skills, transfer in and of itself may need to be taught.

To help students generalize: infuse skill practice, model appropriate responses and attitudes, and integrate computers within the context of activity-based projects or units of study that can occur right in the classroom. For example, instructional objectives such as planning, observing, calculating, and computing could all be simultaneously taught by designing and building a computer club house, right at school---perhaps in the confines of a classroom.

Such a project or unit approach to instruction could encompass all subject matter areas at the same time, in a real-life context, in order to optimize student abilities to conclude, transfer, and generalize (Hunter, 1976). Students might use planning, research, and graphing skills to survey the entire student body on a favored site for the club house, which kinds of computers they should have, and what software selections come closest to matching their curriculum.

The students could then use calculating and computing skills to project a budget for the physical structure of the club house. They would practice negotiating, collaborating, and comparative shopping to select the most economical building materials and equipment for the site. They would incorporate basic math concepts in measuring and calculating the necessary amount of tile and carpeting. And, they would use various language arts and communication skills to publicize its availability, hours of operation, and policies and procedures.

A lesson plan framework, based on Hunter's model, is presented on the next page. The lesson could easily comprise a month of instruction in academic and problem-solving skills as the students go about their charge of building a computer club house. Software is incorporated here and there, as spice tossed into the salad bowl of the classroom.

MINDSCAPE'S LESSON PLAN FORMAT (synthesized from Madeline Hunter's):

Example unit or lesson title: building a computer club house at school

Goals: cooperation, communication, problem-solving, critical thinking

Activities:

Introductory Activities--to break the ice, and orient students

1. ______________________________
2. ______________________________ *
3. ______________________________

Instructional Activities--to demonstrate the skill directly

4. ______________________________
5. ______________________________
6. ______________________________ *
7. ______________________________

Practice Activities--to reinforce skill acquisition, retention

8. ______________________________
9. ______________________________
10. ______________________________
11. ______________________________
12. ______________________________

Evaluation Activities--to measure the extent of skills mastery

13. ______________________________
14. ______________________________ *

---

* = where software might be incorporated

INTEGRATING ONE COMPUTER IN THE CLASSROOM

In addition to using a theoretical approach to incorporate software in routine classroom lessons, the actual computer needs to be logistically eased into the physical facility with aplomb.

The typical classroom has access to one computer. Sharing one computer with many students simultaneously is not easy, but can be done. Treat the computer like an overhead transparency or slide projector (projecting the screen images on the wall with a large screen projection system or using a large television monitor). Then:

1. break students into teams to brainstorm answers requested by the computer; have team members rotate and enter answers in the computer in "relay" mode.

2. have the whole class reach concensus on a solution and allow one person to stay after class or after school to briefly enter the response.

3. ask a student tutor to lead a class discussion and enter responses--as if summarizing notes on an overhead transparency in the front of the room.

4. present the computer task to the class as a set of instruction, a worksheet, or a handout. Assign students to complete the exercises on their own time at a computer station in the library, a lab, or at home.

5. let students work in groups on various research projects, one of which could be computer related so this particular group would have access to quietly work together at the computer.

6. as teacher, use the computer like a slide projector and walk students through screens guiding discussion rather than answering questions or entering responses.

CONCLUSION

Too often an acting-out student, or an accelerated one gets sent to the back of the class for time out with the isolated computer. Effective integration of technology in the classroom can be accomplished by using the computer in front of the class--as with other media--and, by incorporating software only where and when it fits naturally into the established, ongoing curriculum.

REFERENCES

Carnine, D. Mainstreaming computers. Educational Leadership, May, 1984, 77.

Hunter, M. Principles of Learning. El Segundo, CA: Tip Publications, 1976.

U.S. Department of Education. What works: Research about teaching and learning. Pueblo, CO: Author, 1986.

LABORATORY WORK - HOW COMPUTERS CAN HELP

J M QUEEN*

ABSTRACT

During teaching it became apparent that physics laboratory work was causing anxiety to first year h.e. students. An analytical investigation revealed lack of information on equipment, fundamental physics and science methods to be the main contributors to student difficulties and recommendations were made with a view to producing instructional material to overcome these problems. Such material produced for one experiment entitled "Temperature measurement" utilised CAI as a major component and was implemented as a feasibility study for future laboratory development. The evaluation of this experiment showed an improvement in both student performance and attitude. A recent extension of such materials is the development of stand-alone, plug-in interfaced experiments for student self-study.

INTRODUCTION

Many college students not intending to qualify in physics must undertake physics laboratory programmes as part of their course. These students often have little or no practical background in experimental physics. In order to identify the areas of difficulty which students encounter a research exercise using Illuminative Evaluation (ref 1) was undertaken. This involved the recording of every request for assistance by students working in the physics laboratories and noting as a participant observer (ref 2) the problems which they encountered. Students also completed a questionnaire reflecting their attitudes to laboratory work.

THE ANALYSIS

The large volume of collected data was classified and analysed using a system based on Sullivan (ref 3) which categorises tasks into accomplishments (AC), the behaviours necessary to carry out the experiment and acquirements (AQ), the knowledge required to do this.

Analysis (Fig 1) shows that 38% of observations refer in some way to the equipment being used. Of this 19% concerns lack of knowledge on the use of equipment and 6% relates to lack of accomplishment in the use of the equipment. The remaining 13% is external factors.
It is significant therefore that difficulties created by equipment are greater than those contributed by any other single factor in the laboratory programme.

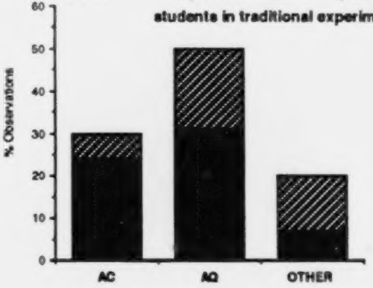


Fig. 1: Analysis of difficulties experienced by students in traditional experiments

Removing the effects of equipment from the data results in 337 comments of which 167 (50%) are acquirents, 134 (40%) are accomplishments and 36 (10%) are attributable to unrelated factors.

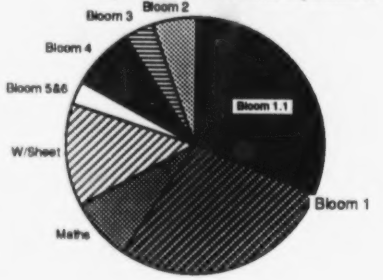
*Department of Physical Sciences, Glasgow College

It is difficult to see how accomplishment factors can be overcome. However, acquirement is a cognitive process and can surely be instructed.

HOW COMPLEX IS THE MISSING ACQUIREMENT?

Acquirement, being the knowledge required to proceed with the experiment is classifiable using Bloom (Ref 4). The results (Fig 2) of such an analysis yield that 78% occur at level 1 of Bloom's taxonomy i.e. basic knowledge and in fact 52% of these are at the lowest level in the hierarchy (knowledge of specifics) be it terminology or simple facts. It can be seen from this that it is the basics which retard the students in their practical work and there is little evidence to show that the existence of higher order levels of acquirement contribute greatly to student performance in the laboratory.

Fig 2 : Analysis of cognitive difficulties experienced in traditional experiments



Clearly the task is to provide a means of overcoming the difficulties associated with using equipment and giving the low order information which students need to complete their coursework.

THE USE OF THE COMPUTER

The computer assistance comprises three parts. Firstly, a pre-test program to acquaint the students with the concepts involved in temperature measurement and calibration curves; secondly, an instructional program for use in the laboratory which directs the student in a lock-step fashion and which also displays the collected data to enable the student to assess the quality and consistency of the collected data; thirdly, a post-test which handles the data and, by testing the student and offering remedial frames, ensures that learning is consolidated.

THE RESULTS

An analysis of the data gathered during this part of the investigation yields the results that only 23% of observations refer to equipment in some way with a mere 6% concerning lack of knowledge about equipment. There is 6% concerned with lack of accomplishment in the use of equipment and 11% outwith the control of the students. However, although the contribution to student difficulty by equipment has been reduced to 23% by careful management and computerisation of the experiment, the introduction of the computer itself has created an additional 17% of difficulties associated with its own use. Despite this additional difficulty there is a significant reduction in student difficulties with equipment and this is noteworthy for it means that in this experiment the student difficulties are mostly generated through their lack of competence in the practical science situation rather than their lack of knowledge of what is going on. Of the acquirements still outstanding there is a noted reduction in the more low level specific types at Bloom 1.1.

WHAT THE STUDENTS SAY

Students were surveyed for their opinions both by completion of a questionnaire and by in-depth interview. Typical comments include that the computer took away the tedium and hard work and left more time to gain practical experience and learn from the experiment. This contrasted with the traditional experiments where "usually the first half-hour is spent trying to work out what you should be doing" and "you can't try things out" which are not specifically mentioned in the worksheet "because you have to get a good lab report" which involved collecting and observing data, not exploring sidetracks. This distortion by lab reports was condemned because "you don't think of the value of the experiment, an awful lot of your mind is saying 'I must get this lab report done'.".

The pre-test program was "good for background when there are no lectures on the subject" and "it gets you thinking along the right lines and puts you in the mood for the experiment". The micro in the lab was regarded as that of omnipresent authoritarian instructor rather than as a calculator for "It's like having your teacher all the time sitting on the desk saying 'Do this, do that ...'" and "it's not acting as the servant - YOU do what IT tells you".

Although "the first time you do it you're in awe of the computer" this instructive manner seems to be what the students wanted for they said they "liked to be told what to do". Certainly "no-one went wrong with the computerised experiment" they said and it looked from the post-test program that "we'll have a lab report which we can see sensible things in". The time allocated seemed "exactly right" for "time flies when you're occupied" especially if you are "a bit more interested in it rather than annoyed with it". There was a sense of reassurance in the experiment which is not usually present for "students ordinarily get very lost in the lab" and are "frightened of not knowing what to do even
when you've got results".

No-one was suggesting that the computerisation of the experiment is the perfect solution for "technicians and lecturers are needed to help with queries" was grudgingly admitted. However, it appears that the computer has a place to some degree whether it is in the camp of "the computer should be there as a backup for you to help you along if you hit a snag" or in the opposite camp of "the computer should be there as the main thing and worksheets as backups".

CONCLUSION

The introduction of computerisation of the experiment and the accompanying educational management and organisation which this involves results in as much as change in ethos as in an improvement of the educational process.

Instant calculations or results frees the intellect to concentrate on physics rather than mathematics while case of experimentation gives a more positive attitude to practical work and the opportunities it presents to explore physics and develop scientific skills. All those benefits have, however, one stumbling block to overcome for one student who plaintively wailed "One thing .... I can't operate the damn computer!!!"

DEVELOPMENTS

Clearly it is not a simple task to extend this format to many students. Much can be done by devolving the pre-test and post-test to mainframe or self-study facilities but perhaps the greatest benefit was that achieved in the lab by clarification of basic pre-requisite acquirements. A laboratory scheme using a lab booklet based on this philosophy is now successfully in use by some 350 students.

INTERFACING

The scheme described was utilised to overcome, essentially, basic acquirement problems but what about accomplishment problems and problems associated with higher order analysis/interpretive skills? Many of the problems which illustrative physics experiments suffer is that the data never quite works exactly - it seems almost inevitable to have to 'correct' data for variations which, although genuine and perfectly valid, are never fully believed by the students. These variations obscure the basic physics principles which students are meant to interpret. One approach to this is to collect large quantities of data and average the result, a task which cannot be reasonably expected of even the most dedicated student but which is within the capability of an interfaced computer. This highlights the next problem - to interface a computer to a physics experiment requires a great deal of available time as well as skill in physics, computing and electronics. The solution is the plug-in interfaced complete experiment which generates data for thoughtful analysis and need not even be done in a laboratory. Because it is a simple plug-in it also circumvents the need for accomplishments and may be a solution to this problem.

This is still in its infancy but it will be interesting to see how this development is received and utilised. It is expected that some trials may be undertaken during the coming year.

REFERENCES

1. M. Parlett and D. Hamilton, Evaluation as Illumination (Occasional paper for Centre for Research in the Educational Sciences, Edinburgh 1972)

2. H.S. Becker, Problems of inference and proof in participant observation (in Sociological work, Allen Lane, Penguin Press 1971)

3. H.J. Sullivan, Objectives evaluation and improved learner achievement (in Instructional Objectives, Rand McNally 1969)

4. B.S. Bloom, A taxonomy of educational objectives: Handbook 1 - The Cognitive Domain (Longmans-Green, NY 1956)

COMPUTER SIMULATION OF LABORATORY METHODOLOGY IN PHARMACOLOGY

D. Wood and J.M. Noras*

ABSTRACT

Many undergraduates in Pharmacy and other Life Sciences experience difficulty with quantitative aspects of Pharmacology, particularly in applying theory, traditionally taught in lectures, to the analysis of experimental data. Problems in learning are exacerbated by the limited time available for this section of the course, by the need to handle new apparatus and by the necessity of analysing data which are subject to biological and experimental error. We present an approach intended to reduce these learning difficulties while retaining all the factors that complicate the acquisition of real data.

INTRODUCTION

It seems old-fashioned and almost heretical to advocate computer-aided teaching without the benefit of such powerful aids as authoring languages and graphical display of information. Of course, these aids are increasingly useful in a wide variety of applications, but tend to require commitment of resources either in terms of hardware or development time. However, we find that it is possible to enhance students' learning rate and understanding using quite unsophisticated computing tools which address difficult topics in a realistic way, as part of an integrated course of lectures and laboratory work. In this paper we discuss a package to teach experimentation in pharmacology to a range of undergraduate groups.

EDUCATIONAL OBJECTIVES

In many disciplines, students find that the difficulty of acquiring new experimental techniques is compounded by their imperfect grasp of the theory necessary to understand and analyse the results. This is especially true in the Life Sciences, where biological variation and the urgency required in dealing with living tissue are additional factors.

Often the methodology is taught not just to illustrate lecture material, but because students will require the skill in project work or in their future employment, perhaps on a daily basis. Increased lecturing is inappropriate, while extensive laboratory periods are hard to schedule and costly in resources, both material and human.

We have produced a set of simulation programs, designed for undergraduate use, to complement lectures and to assist learning and appreciation of basic quantitative principles in pharmacology. These can be used on their own or in conjunction with laboratory work.

Schools of Pharmacology and Electrical Engineering*
University of Bradford, Bradford, BD7 1DP

Accompanying worksheets lead the students through the sequence of activities that they would perform in an actual experiment: generating concentration-response data, manually plotting curves of the raw or appropriately transformed data and reading off or calculating various parameters.

We choose not to display data graphically but simply to present numbers as they would be obtained from a real situation. We believe that simulation of a realistic nature lets students understand how theory meshes with experiment, without the distraction of apparatus to manipulate, but with the benefit of handling data. Thus we retain as many as possible of the physical activities that will be required in the laboratory.

IMPLEMENTATION

1. A suite of programs was written in Fortran, to simulate the contractile effects of drugs on isolated tissues and illustrate various aspects of the drug dose-response relationship, for instance the importance of affinity and efficacy, the effects of competitive antagonists, etc.

2. Some lectures were replaced by supervised tutorial sessions, at which each student had access to a Mainframe terminal. Our direct approach is thus flexible and requires minimal specialised computing resources.

3. Students were provided with work-sheets.

4. In running a simulation, each student directed the dosing sequence and was presented with values of the contractile response with additive noise.

5. The student was required to plot appropriate graphs manually, to extract relevant parameters, carry out other analyses and discuss their interpretations both orally during the tutorial and subsequently in written form.

6. Students were able to repeat entire runs as necessary, during the session or in their own time, and could explore situations other than those described in the worksheet.

   The simulations let them see the effects of changing parameters in a form that they can grasp, whereas most would not be happy to investigate these changes using algebra or calculus.

7. Ideally, within a few days of each tutorial, students performed a laboratory exercise on the same topic. In the laboratory, an experiment typically took four hours to complete whereas the equivalent simulation took 30-40 minutes and covered a wider range of material.

8. The tutorial and practical sessions could be consolidated and integrated by means of a review tutorial.

CONCLUSIONS

This computer-assisted learning package has been tested on two groups of undergraduates, at the University of Bradford, U.K. and at Monash University, Australia. Because of our small sample numbers we cannot draw firm conclusions, but it appears that experience of this package, with its facility for re-running simulations until the approach and analysis are correct, does prepare undergraduates to carry out experiments with greater understanding and economy of materials and time. The package has clear academic portability.

Volunteers completed a questionnaire on the package. In general, reactions were favourable, and students thought their time well spent. A number of suggestions for improvement and development have been incorporated already, and we are adapting the software in response to requests for more direct feedback, so that users can assess the appropriateness of their experimental method and analyses and their requirement for assistance.

DEVELOPING SCIENTIFIC THINKING THROUGH THE USE OF COMPUTER MONITORING

C. T. Opie

ABSTRACT

Heuristic techniques of working are seen as desirable aims in teaching and certain types of computer assisted learning (CAL) can play an important role in providing the means whereby such aims can be achieved. Such a form of CAL has been developed, in partnership with local teachers, which exploits the potential that computer monitoring offers for encouraging student centred learning within practical science lessons. Examples of its usage by students and the pedagogical advantages that it offers are described.

MODE OF LEARNING

Original thought is discouraged by didactic teaching and the acquisition of static knowledge by passive minds is encouraged by rote learning. The realisation that in the face of a rapidly changing technological society such methods of acquiring knowledge are of limited value, is bringing about changes in teaching styles and activities in schools. Such changes are promoting heuristic methods of working and the development of original thought through experiential learning. An heuristic approach helps provide pupils with the enquiring minds needed in a complex and ever changing society. Support for these changes comes from many quarters e.g. Self (Ref 1) who writes:

> 'It is recognised (as it has always been in educational philosophies) that the content of knowledge is much less important than higher level skills, such as knowing how to reason about knowledge, how to acquire new knowledge, how to adapt it and so on. With the increasing pace of change such skills are even more crucial. Now the focus is more on the activity of learning rather than the result.'

Of the four types of CAL , 'Skill and drill', 'Simulation', 'Conjectural' and 'Emancipatory' proposed by Kemmis et. al. (Ref 2) and discussed in further detail by Wellington (Ref 3) and Terry (Ref 4) it is widely accepted that the latter two types provide the potential for encouraging heuristic methods of working.

CAL - SIMULATION VS REAL EXPERIMENTATION

Recent surveys by the Department of Education and Science (Ref 5) and Welsh Office (Ref 6) shows that on average 35% of the schools surveyed use computers in their Science teaching. Findings, as yet unpublished, suggest that as little as 8% of this usage is with conjectural and emancipatory types of CAL whereas 68% is with simulation CAL. This imbalance is not to be inveighed against, simulation CAL has many merits, but there are dangers in substituting a simulation for a real experiment as Neuwirth (Ref 7) points out:

Division of Education, University of Sheffield

> '... one might easily conclude that it is not necessary to perform any experiment physically since it can be replaced very easily with an informative simulation. This way of thinking will ignore completely the fact that every simulation implies a theory about "the world", or at least some aspect of it, since it only works as an implementation of a model which must exist in advance. On the contrary - a real experiment is a question posed to nature; a simulation is an illustration of answers already given by others.'

Experimental design, data collection and the analyses, deductions and hypotheses generated by such data are the very heart of scientific investigative work. Why is it, then, that the majority of science practical lessons do not encourage such work. Indeed they allow students to "do" little, if any, creative work or develop critical thinking as success is often dependent on obtaining the "right" results. Only by enabling a student to make choices, to justify them and see their effects, will he or she learn about the process of making educated decisions. Only in this way will he or she become self-evaluative and learn how to learn.

It is the dangers of simulation CAL and the desire to promote scientific thinking in practical lessons that prompted the recent CAL development at Sheffield University, Division of Education.

SHEFFIELD PROJECT

In participation with local science teachers a new piece of CAL, which bridges the conjectural - emancipatory types, was designed to enable students to monitor physical and chemical changes for themselves and to be in control of their own learning. Its ease of use and the fact that it overcomes the time consuming and tedious process of data collection make the use of this CAL a viable alternative to the "cookbook" laboratory set up. The important feature of this CAL is that it does not simulate the measurement of physical and chemical changes. The CAL is used in conjunction with commercially available electronic sensors and early evidence suggests that it does provide a means whereby student centred learning is facilitated.

EXAMPLES

After monitoring changes in pH while adding strong alkali to strong acid and producing the pH curve (Graph 1, Fig 1) shown two sixth formers had the following discussion:

Student 1. "That was easy to do. Let's see what we get if we add the acid more slowly."

Student 2. "Well all we will get is a slope. It won't change so sharply. That's all that will happen."

Further work produced the second pH curve (Graph 2, Fig 1).

There was initial surprise at the result and concern was expressed that the experiment had "failed". However, after further reasoning the students deduced the fact that the graphs were indeed as would be expected. The example shows how this CAL had allowed the students to investigate their own ideas and perhaps eliminate a misconception that

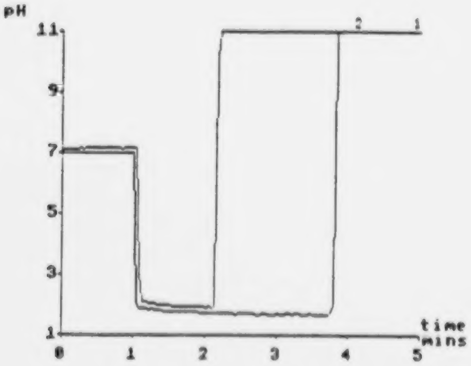


Fig 1. pH curves of
strong acid/alkali

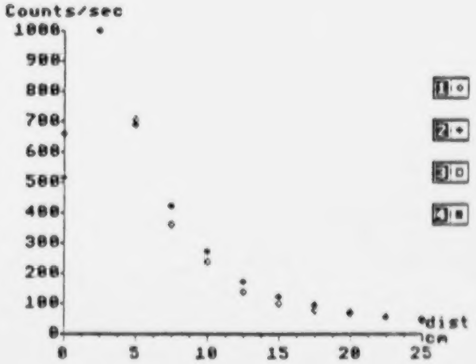


Fig 2. Radioactve decay
of strontium source

they held. They promptly went on to plot pH curves of adding combinations of weak and strong acid and alkalis and to discuss the results. An advantage of this CAL is that it provides students with the possibility of quickly repeating short experiments and to test out actively their own hypotheses. Surely this was more productive than the other option open to them - discussion of such results from diagrams in a text book?

Similar ease of experimentation and monitoring resulted in discussion by fifth form pupils of their findings when plotting radioactive decay against distance (Fig 2) and by fourth year pupils producing magnetic field measurements of a bar magnetic (Fig 3).

Second year pupils carried out a common experiment to elucidate the conductivity of water. Water was heated at the top of a boiling tube. The water temperature at the top (Graph 1, Fig 4) and at the bottom (Graph 2, Fig 4) of the boiling tube was monitored electronically.

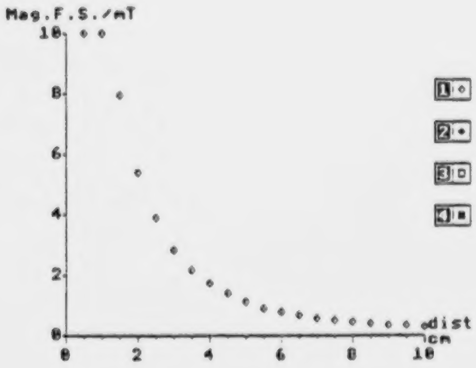


Fig 3. Magnetic field of
a bar magnet

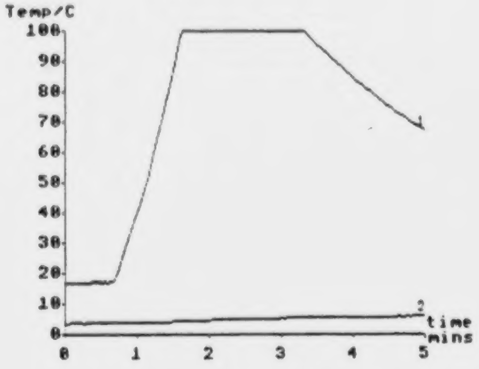


Fig 4. Temperature changes
of water

These second year pupils students printed out their results and took them away for further discussion. This provided them with the means whereby they could study their results graphically - a feature not often available in most science lessons.

Apart from these student examples this new CAL has been used on numerous in-service courses and in all cases it has been most favourably received. Samples of the CAL have been sent to colleagues in Sweden and Australia in an attempt to elicit their opinions. At the time of writing trials in these two countries have been limited although initial findings complement those of the U.K.

PEDAGOGICAL ADVANTAGES

1. It encourages students to investigate physical and chemical changes that interest them and to make inferences and hypotheses about their investigations.

2. It encourages critical thinking skills by reducing the drudgery of data collection and manipulation. The student is still in control, although many of the tedious aspects of monitoring, storing and display of data are eliminated.

3. It enables students more often to have the time and inclination to ask their own 'what if ....?" questions and provides the means whereby they can collect data in the attempt to answer these questions.

4. Its ease of use and immediate display of data allows concentration on the science behind the data. It also provides a 'sense of success' which increases students' motivation to experiment further.

5. It encourages co-operative group work.

REFERENCES

1. J. Self, Microcomputers in Education (Harvester Press, 1985), p 137.

2. Kemmis et. al., Occ. Paper 5, Centre for Applied Research in Education, University of East Anglia, (1977)

3. Wellington J. J., Children, Computers and the Curriculum, (Harper & Row, 1985), p 59.

4. Terry C., Using Microcomputers in Schools, (Croom Helm, 1984), p. 25.

5. DES, Results of the Survey of Microcomputers etc in Schools, Statistical Bulletin 18/86, (1986)

6. Welsh Office, Survey of Microcomputers in Schools, Statistics Bulletin No.3, (1986)

7. E. Neuwirth in R. Ennals et. al., Information Technology and Education, (Ellis Horwood, 1986), p 26.

THE AUTOTUTOR TO CD-ROM: A TWENTY-YEAR, PERSONAL PERSPECTIVE ON TECHNOLOGY IN THE CLASSROOM

M L Harris

ABSTRACT

This paper traces developments in the application of technology in the classroom from the mid-1960s to the present. Drawing on career experience that has included Autotutor materials development, state-level policy making in educational technology, and teacher/administrator education the author highlights the major efforts to bring technology into the classroom.

The introduction of the various technologies has usually been accompanied by promises of great improvements in education, especially in student and teacher satisfaction, efficiency, accountability and curriculum standardization. These promises are examined from the perspective of the technology proponents, the educational establishment and the teacher.

We also compare early applications of technology that were mostly driven by ideas about learning, especially those of Norman Crowder and B F Skinner, with today's emphasis on "delivering the curriculum," which is largely independent of educational theory (with the notable exception of Logo).

The critical issues of teacher and administrator training, changing "the curriculum", and restructuring of the instructional day to maximize the benefits of technology are also examined.

The paper concludes with an analysis of the common factors underlying the introduction of technology, the common barriers to institutionalization and what the past twenty years might tell us about how to embark on the next twenty.

Computer Access, P O Box 1513, DAVIS,CA 95617, USA

INTERACTIVE VIDEO AND EXPERT SYSTEMS

C.P.Tompsett *

ABSTRACT

Expert systems are designed to handle knowledge and applications of this knowledge in the same way as humans. They offer the opportunity to create a learning environment in which the learner can interact directly with an active model of the knowledge that they are required to learn. Video disk technology offers the potential resource of 55 000 images related to a knowledge domain.

Most work on expert systems used in training has been carried out in technical domains with a high formal content such as computer programming or medical diagnosis. Such domains are far more structured than those that present typical training problems. Training in new engineering technology requires adding new knowledge with looser concepts and ideas that the students already possess. Linking interactive video-disk directly to the knowledge-based description of the domain provides a vital extension to the formal structure of the domain given by the knowledge representation.

INTRODUCTION

The Knowledge-Based Engineering Training project, funded by the ALVEY programme , has developed a knowledge-based training tool for CNC milling using interactive video as a training medium. The partners on the project included Logica, Imperial College, Exeter University and the Engineering Industry Training Board. The Information Technology Development Unit, working for Imperial College was responsible for the knowledge base and tutoring architecture. Knowledge representation is linked to a logic based video description language developed by Imperial College. The tutoring system identifies images to present directly from appropriate descriptions of the images on a video disk.

Exeter University was responsible for user modelling aspects of the project, The Engineering Industry Training Board (EITB) provided a source of expertise for the domain and managed production of video disk work. Logica, who were prime contractors, retained overall responsibility for the project and integration of the separate shell components. Logica were also responsible for the user interface software and shared development of dialogue work with Kingston.

KNOWLEDGE DOMAIN

A market survey conducted by the EITB in the early months of the project identified initial training for Computer Numerical Control milling applications as opposed to training for conventional milling work as a domain critical to development of the engineering industry within the UK. The inherent cost of video-disk production, linked with its potential flexibility, suggested that the target audience should be as broad as possible and include the whole spectrum of workers in the industry, from managers to craft operators. This required sophisticated user modelling techniques to allow for different priorities between individual learners and between different user groups. It also required a unified knowledge representation for the domain that could link operating procedures to financial costing, safety considerations and management information flow. Subsequently the knowledge domain was restricted to consideration of the tooling systems now produced for CNC installations. The design of such tools has changed to reflect new capabilities of the CNC machines and their different operating capacities and costs. This more restricted domain still illustrated the same technical problems but provided a more manageable knowledge acquisition task.

---

* Head,Information Technology Development Unit, Kingston, KT1 2AQ

Expert systems solve problems for those who have a working understanding of the terminology used. The initial problem of knowledge representation in a tutoring system is to ensure that problems in the domain can be solved on this basis. Knowledge representation was required by the project to meet several criteria. Major criteria were:

1 integration of procedural and declarative knowledge

The simplest distinction between procedural and declarative knowledge is between sequence dependent and sequence independent information. Within the literature there has been much discussion as to whether such a distinction is artificial or required in expert systems. However as the distinction exists in common language and in the training field it should be clearly represented in a tutoring system. Moreover, if the two forms of knowledge are to be integrated the knowledge representation system must specifically show how inferencing can use both forms of knowledge together. The procedure to be followed at any point in time is most often the result of planning the activity on the basis of other relevant declarative knowledge.

2 compactness of representation

To support the user modelling aspects of the domain the interrelationships between all pieces of knowledge should be clearly shown. Thus the system can use a student's ability in one area of knowledge in a similar areas to speed and guide the learning process. Compactness could also speed the knowledge representation process.

3 segmentation of knowledge

Most useful, non-formal domains are complex areas of interrelated knowledge. Strictly hierarchical structures, often encountered as syllabuses in tutoring systems, are typically abstractions from a more closely connected network structure. The knowledge representation must reflect this inter-connection but at the same time exploit separation of each sub-domain wherever possible. Different users require a knowledge of the separate areas to different depths of understanding. If the knowledge is too highly segmented, it will be too complex a task to represent individual users' requirements from the tutoring system and monitor current understanding.

A wide variety of representations were considered from the literature (ref 1 provides a sound starting point). Frames provide a good mechanism for segmenting the domain and have been successfully applied elsewhere as in Steamer (ref 2). However most frame based systems specifically segregate declarative and procedural aspects. In addition the control of inference is often obscure and provides little help in guiding students towards a solution, one of the problems noted by Clancey with respect to Guidon (ref 3).

Logic based representations, such as First Order Logic (with associated computational problems) or Horn Clause Logic, provide segmentation at the lowest level of individual facts and rules and also over-emphasize relationships as opposed to object types within the domain. However logic does provide a homogeneous representation for inferencing and, with suitable attention to the knowledge that is recorded, can provide some guidance as to a method of solution.

The system selected was based on the epistemological view of semantics net as proposed by Brachman for KLONE (ref 4). This representation uses a semantic network of concepts with structured inheritance. A concept is defined in terms of a set of role descriptors and a set of structural descriptors. The role descriptors identify a concept with a set of roles. Each role is defined as a set of four components which are a name, a restriction on the type of concept that can fulfil that role, a restriction on the number of distinct objects in that role and a modality specifying the existence relationship between the role and the parent concept. The structural descriptors provide further restrictions on the complete set of role fillers by providing logical restrictions between the role fillers.

This structure provides a clear segmentation of the domain onto a concept framework with specializations associated with each concept. The use of logic for structural descriptors provides a straightforward mapping between problem solution and inferencing. The major criterion it still needs to meet is the integration of procedural and declarative knowledge. This is met in KBET by applying the same representation at a metalevel to structure knowledge into separate types, with the interrelationships defined by the metalevel structural descriptor and role descriptor information. This metalevel classification includes acts, act sequences, decisions and plans. In addition to linking procedural and declarative knowledge formally, this separates the procedural aspects of the domain into knowledge of how to execute a sequence of actions and the justification of why such a sequence is valid.

FORMAL AND INFORMAL KNOWLEDGE

Tutoring systems must add two further functions. Firstly they must have some ability to vary the presentation of a problem, such as coaching a student through a problem or testing them. Secondly they must be able to organize and present new material. The first problem can be approached through a mirrored approach, similar to the 'Query the User' structure proposed by Marek Sergot (ref 5). The second, in addition to features that can be abstracted from the structure of the knowledge base, requires a distinction to be drawn between what can encoded within a knowledge based representation and what is required to understand and apply a body of knowledge.

Knowledge representation provides a purely formal representation of the domain. A tutoring system based on this is restricted to teaching logical links and dependencies within the knowledge domain. In a training system we need to provide an extension to this tutoring as few people apply their knowledge in a formal manner. Certain characteristics will be true of an informal understanding of an area of knowledge that are not necessarily disadvantageous. In informal knowledge the critical distinction is between truth and falsehood but a formal domain distinguishes between axioms and theorems as well. In applying knowledge the user must understand the reference of terms and relate this to other knowledge that is already understood but formal systems only reflect closed and syntactic manipulation of knowledge. For training the user/student is assumed to start from a weak informal understanding of the outline of a topic and should finish with an understanding that can be efficiently applied within an informal context and which is supported by a formal understanding of the domain. Schematically this development can be shown as:

informal ⇨ FORMAL ⇨ **INFORMAL**

Traditionally training omits the intermediate step. The disadvantage with such an approach is that small changes in formal knowledge can produce radical changes in informal knowledge. In the rapidly changing engineering industry a person trained on this basis may require retraining within only two years. However knowledge-based training systems that emphasize the intermediate stage of formal understanding must ensure that these mappings can be clearly established. If the first is missing then students' prior knowledge is lost and if the second is missing then new understanding is unlikely to be applied.

Within KBET the knowledge and information collected was divided between knowledge that was formally represented and information that was given equal weight by the experts during elicitation but which was not required to support solution of problems. The formal knowledge was mirrored by text presentations of the same information, allowing for richer use of language than is possible with direct presentation of the knowledge as formal structures or rules. The informal knowledge, such as definitions and introductory material, provides additional contextual backing to the formal context. Thus a concept will be formally defined explicitly in terms of its constituent role and structural descriptors but the informal definition may, for example, also include intentional knowledge. However, the tutoring system will not understand the informal definition in any sense at all.

INTERACTIVE VIDEO

The use of interactive video-disk technology has often been at a relatively low level of application. The technology is impressive but few systems have begun to explore the potential. Applications can be considered at four distinct levels in relation to a knowledge based system. At the first level material can be used 'hard-wired'. Specific video frames and sequençes are called as required by frame number encoded in a presentation. This use is identical to the use of text presentation described above. The system does not 'know' what a frame shows or includes, it merely presents the frame as instructed. At the next level video frames are indexed against fixed descriptors by applying standard database techniques. This allows for interactive selection of frames to present and is currently applied on some of the more imaginative educational disks available.

The level applied within KBET is a significant extension to this, devised by Chris Roast of Imperial College (ref 6). A visual frame is represented by a logical description of the objects visible and the relationships between them. When complemented by an appropriate inferencing system (also by Chris Roast) the formal knowledge inherent within the description can be exploited allowing frames to be selected by transforming the required unmatched description to a formally equivalent one that can be matched. The highest level is worthy of a project in its own right but would require a distinction between knowing that a frame

SHOWS "aluminium being cut by an endmill" and/or

SHOWS THAT "aluminium is being cut by an endmill".

At the level used by KBET the descriptions of the video frame are considered to be part of the domain knowledge base. They contribute a knowledge base of cases that can be used wherever the tutoring system can describe, from its current context, the essential content of an image to be shown.

The power that such a system embodies is encapsulated in its ability to present new material to a student or user. The formal aspects of a new concept are the target of the tutoring system but little will be 'comprehended' unless the student has an appropriate image on which 'hang' the new knowledge. At the earliest stage of introducing a new concept, KBET is able to illustrate the concept with visual images. This provides the student/user with a visual image of the concept and, if selected appropriately, the image can be shown within a context that is otherwise already understood by the student, conveying a considerable amount of informal knowledge relating to the new concept .The capability of the system to understand the content of the image in formal terms also opens up the video image as a two way communication channel, with the student being able to interrogate the image and the knowledge it expresses.

1. A.Barr and E.Feigenbaum, The Handbook of AI vol 1 (William Kaufmann Inc, 1981)
2. J.D Hollan et al,STEAMER: an Interactive Inspectable Simulation-based Training System (The AI Magazine, vol.5.2)
3. W.J.Clancey and R.Letsinger, NEOMYCIN: Reconfiguring a Rule-based Expert System for Application to Teaching (proceedings of IJCAI-81 pp829-836)
4 R.J.Brachman On the Epistemological Status of Semantic Nets, in Associative Networks (Associated Press 1979, ed N.V.Findler)
5. M.Sergot, A Query the User Facility for Logic Programming (Imperial College DOC 82/18)
6. C.Roast, Considerations for Formally Describing Images (KBET Project Report, 1986)

AN EXAMINATION OF APPLICATIONS OF NEW INFORMATION TECHNOLOGIES TO IMPROVE INSTRUCTION IN VOCATIONAL EDUCATION AND TRAINING PROGRAMS

Dennis D. Gooler Gene Roth

In the State of Illinois, as in other states and nations throughout the world, fundamental changes are taking place in the nature of the workplace, and in the needed characteristics of the workforce. In many states and nations, an increasing proportion of people in the workforce are required to work with information in various forms, or are required to exhibit new kinds of problem solving skills and strategies due to the presence of new technologies in the workplace. Many writers have argued that these kind of workplace changes mirror broader changes in the society more generally, and that such changes are likely to occur with increasing rapidity in the future. Social and workplace changes are, in turn, dramatically influencing how individuals work, play, think, and generally lead their lives.

Recognizing the importance of these fundamental social and work changes, and the need to review existing programs with an eye toward developing and providing more effective instructional programming, the Illinois State Board of Education, through the Division of Adult, Vocational, and Technical Education, funded a research project at Northern Illinois University, the purpose of which is to identify state-of-the-art instructional needs of education for employment programs and systems. The project will result in three products: a Sourcebook of information on new instructional technologies and their potential applications in vocational education programs; a Casebook of descriptive/analytical case studies of instances of the application of a selected number of technologies; and a Handbook to assist educators and policy makers to systematically plan for the selection, implementation, and evaluation of emerging technologies for use in vocational education programs. These products will form the foundation for the next phase of the project, which involves establishing pilot/demonstration sites for further research on selected technologies.

Of particular interest in the Illinois project are two matters: an exploration of the potential applications of newly emerging integrated information technologies (i.e., those technology systems that feature extensive integration of computer, video, and telecommunications technologies, that make possible high levels of interactivity for learners, and that include potential for the development and use of expert systems/knowledge engineering-based instructional strategies); and the uses of such technology systems in an open learning or distance learning configuration. The distance learning consideration is of special importance due to the pressing needs of rural communities in Illinois for students to have access to high quality instructional programming which is often not currently available to them because of lack of resources and geographical isolation. The technological characteristics of the new integrated information technologies suggest that these technologies might be

---

*Dennis D. Gooler, Northern Illinois University, DeKalb, Illinois, USA
Gene Roth, Northern Illinois University, DeKalb, Illinois, USA

powerful modes for delivering in a distance learning format the kinds of instructional programs required by vocational education, but a more detailed analyses of these characteristics is necessary, and is the primary focus of work on the Illinois project. This paper contains a report of progress on the project to date.

A first step in the project has been to conduct a poll of key Illinois vocational education personnel. The telephone poll, conducted by the Public Opinion Laboratory of Northern Illinois University, is aimed at determining current attitudes and experiences held by Illinois vocational educators concerning uses of technology systems for instructional purposes. The poll is also intended to elicit opinions as to acceptable costs, training requirements, and changes in curricula of new instructional technology systems in vocational education. These opinions and attitudes are judged critical to the ultimate widescale acceptance of new technology systems in vocational education. The poll will be conducted in late January, with the results available in late February (in time for some reporting at the Conference in March).

A review of literature of current instructional technology applications in vocational education is being conducted as part of the project. While that study has not been completed to date, suprisingly little literature on the topic has been uncovered. The review thus far, however, suggests that vocational educators are faced with needs to deal with technology in the vocational education curriculum in at least three ways: (1) students must gain a general understanding of the character and role of technology in society in general, and in their own lives in particular; (2) as the workplace demands more involvement with technologies in virtually every sector, students must learn how to use a range of technologies in whatever employment path they choose; and (3) students and teachers need to learn how to use technologies for instructional and learning purposes. The literature reviewed suggests some attention has been paid to the third point, primarily focusing on uses of microcomputers for instructional and career guidance. Historically, of course, much of vocational education has been directed at helping people prepare to deal with job-related technologies, and that trend continues, with more focus being given to new technologies in the workplace. The primary issue here is that schools often have difficulty keeping up with these technology changes, both in terms of the training of teachers and the availability in the schools of relevant technologies for students. The discrepancies between what is available in the schools, and what people encounter in the workplace, has led to continuing dialogue about the appropriate roles and outcomes of vocational education. And the literature reveals little systematic effort to prepare students more generally for technological change.

In addition to reviewing extant literature about technology applications in vocational education, project staff are developing reviews of technologies that appear to hold promise for applications in vocational education, even if those technologies are not now being widely used for such purposes. The reviews being conducted as part of the project are particularly challenging: the intent of the reviews is to place in the hands of vocational educators pragmatic information they can use to ascertain the potential applications of a given technology system in their unique instructional environment. The reviews thus need to have solid content about the technology in question, but must be rendered in a way that an individual with little knowledge of the technology can determine whether that technology might be useful in his or her setting.

Reviews being conducted focus on: (1) microcomputer applications; (2) emerging and traditional forms of video technology applications; (3) interactive video technology applications; (4) integrated information technology system (computers, video, telecommunications) applications; and (5) applications of expert systems/knowledge engineering/artificial intelligence systems. For each of these kinds of technologies, vocational educators will receive information on the concepts involved, applications in vocational education alternatives, hardware and software requirements, training requirements, and other issues to be taken into account in deciding whether to use a given technology. To date, the first drafts of these reviews are being completed, and will be reviewed and revised as necessary. These technology system-specific reviews, together with the more general review of instructional technology applications currently practiced in vocational education, will comprise the bulk of the Sourcebook being created. In addition, the Sourcebook will contain information about related issues, such as staff development, evaluation, etc.

As a means of providing further information to vocational educators about technology applications, a Casebook of instances of instructional technology applications is being prepared. Five case studies are being developed:

> Two way interactive video and data networks: Telesystems Associates has developed a two-way interactive system that delivers courses to schools in a way that permits high levels of interactions among all students taking the course. The system appears to hold great promise for delivering vocational education courses to remote sites without losing the essential characteristics of effective instruction.
>
> Model technology classroom: Sacramento, California has developed model technology classrooms making possible the delivery of powerful instruction through the careful integration of a variety of technologies (e.g., microcomputers, video, telecommunications, etc.).
>
> Technology applications in business settings: Arthur Andersen and Company operates a technology-based instructional center in suburban Chicago, representing one of the more progressive and effective examples of instructional applications of technology for training and development.
>
> Technology integration in vocational education curriculum: A New Jersey high school has developed a vocational education program that features a technology-based curriculum that draws together the departments of physics, chemistry, math, and vocational education.
>
> Computer networking: A recent technology advancement has created new possibilities for increasing the instructional effectiveness of microcomputers in schools. A case study of an IBM networking project in a Chicago high school will illustrate these advancements.

In addition to presenting the five cases mentioned above, the Casebook will attempt to help users understand the common themes and issues that cut across cases of technology applications, and will assist users in judging the appropriateness of these kinds of technology applications for their particular setting.

The Illinois project also involves developing a Handbook. This handbook, drawing on information contained in the Sourcebook and Casebook, will provide for vocational educators a practical approach to technology planning. The Handbook will contain guidelines for what to take into account in deciding about technology applications, how to most effectively prepare the setting for adopting the technology, and how to evaluate the uses of the technology. Preliminary work on the Handbook has begun, but completion of that product must necessarily wait until the Sourcebook and the Casebook are near completion.

The final aspect of the Illinois project involves selecting approximately six sites to become demonstration sites during a second year of the project. Each site will focus on the applications of a particular instructional technology, will test out the uses of that technology in vocational education, will provide training in how to use the technology, and will be available to vocational educators outside the six sites to visit, ask questions about the technology, etc. Preliminary planning with the six sites will begin in the Spring of 1988, with implementation expected to commence in the late summer.

It is already evident that many Illinois vocational educators are unfamiliar with emerging technology systems that may have potential for enhancing vocational education in the future. Demands made by a changing workplace, and a changing society more generally, cannot go unnoticed by those responsible for preparing future workers. New technologies are likely to change not only how vocational education is provided, but what is taught as well. The Illinois project is attempting to help vocational educators prepare themselves to deal with a changing future.

SOFTWARE FOR COMPUTER AIDED LEARNING IN MATHEMATICS

C.Beevers, B.Cherry, D.Clark, M.Foster and G.McGuire. (*)

ABSTRACT

This paper aims to describe a number of software tools designed for preparing Computer Aided Learning materials (CAL) in Mathematics. The CALM Project, based at the Heriot-Watt University, is one of the projects in receipt of funding from the Computer Board of the UK as part of the Computers in Teaching Initiative within British Universities. This article will outline the CALM Project and deal specifically with CAL in Mathematics. The software produced on this project has been tested by groups of engineering students.

INTRODUCTION

The way the computer helps the learning process for humans is not properly understood yet. In the Mathematics Department of the Heriot-Watt University we are investigating the role of the computer in the education of large groups of first year engineering undergraduates in a typical Scottish University. This paper seeks to describe the project known as the CALM Project illustrating the description with examples of the software so far developed. The final section sets out the lessons learnt from three terms use of the CALM software.

The Heriot-Watt University is a small technological university and its Mathematics Department has a major service teaching commitment. In their first year the students spend 3 hours per week on Calculus at a level above Scottish Higher Grade Mathematics. Our large service commitment coupled with limited resources has produced an ineffective tutorial system for a minority of the students. In the past, pen and paper tutorials have operated with the tutoring role done mainly by postgraduates. The better students do not suffer but inevitably the less articulate students fail to understand mathematics at an early stage and they struggle with it for the rest of their university careers. Some students become despondent and opt out of the system altogether. In 1985 we put forward the idea of a computerised tutorial system to enhance the teaching of Calculus for engineering students. We aimed to produce material to back-up the conventional lecture, to provide instruction for the students and to test their understanding. These categories, then, form the three components of each topic we cover. The basic structure of our software has a theory section made up of screens to consolidate the lecture; a worked example section which instructs the student in ways of doing Mathematics and then to emphasise that Mathematics is an active subject each week's work (designated a unit) has a test section. We have taken a broad interpretation of the worked examples section with standard solutions being supplemented by mathematical 'games', simulations, mathematical modelling and experimental sections. At the beginning we had not realised just how powerful the assessment element can be for students and they appear to 'enjoy' the weekly challenge to test their knowledge (full details on the test appear in [1]).

*Mathematics Department, Heriot-Watt University, Edinburgh

CAL IN MATHEMATICS

A team of six academic and programming staff was formed in 1985 and we made our first programming decision when we chose to work with Pascal. The reason was a natural one based on the availability of Pascal across a wide range of modern micros. In our software development there have been a number of stages: we started writing self-contained programs but soon realised that there were common parts that could be put into a library of useful routines. Originally this library was pulled into our programs at compilation time but then we made an object version of the library that could be linked to a program after compilation. Now, the library has been compiled in segment form so that the linking can be selective. Thus, we obtain executable files ready to run on the network of 32 RM Nimbus micros.

At the end of the project we intend to leave a legacy of software tools for other teachers who want to prepare their own CAL material. This echoes the sentiment in an article by Harding [2]. In this context we have identified a number of software tools like menu screen layout, split screen creation, text handling routines and screen editing facilities. Easy access to all parts of a week's unit was one of our first priorities. It is essential that students should be able to jump around topics easily so that they can go to those parts of the course they are finding difficult. This direction to specific parts of the software is achieved by use of a printed 'worksheet' given out a week in advance of the computer tutorial session. This works well with some students opting for the theory of one topic, others for the worked examples on a second topic and the more confident going straight for the test. In fact our evidence shows that typically during the hour long tutorial students spend 15 minutes checking the theory and worked examples sections before opting for a test. Throughout we have designed our material in small chunks so that it does not become set in concrete. It may be too that another teacher would prefer to teach topics in a different order and this we have borne in mind. The access then to all parts of the software has been by simple but colourful menu screens with the students in charge of the pace of learning.

The ability to place and move text and fractions on the screen, in different colours and with variable height and width has been most helpful in designing stimulating software. For display we have found it useful to have a number of procedures for moving students on through a program. Such routines have been employed extensively throughout the worked examples section and always the program control remains with the user. Split screens have been designed to allow important information to stay on part of the screen when other details are removed. Thus, vital equations can be shown on part of the screen while a continuing argument rolls alongside.

One of the main problems that we have encountered in developing the mathematical CAL software has been some parts of the computer/student interface. In the system that we have devised it is a major feature that the students are able to input the results of mathematical problems. This requires the student to put into the computer complicated mathematical formulae involving a range of symbols and expressions usually in computer format. A fundamental drawback of any computer system is that it expects these inputs in a very precise fashion and, although the computer is a very patient teacher, at the present stage of development, it is also a very stubborn one! The solutions to many problems can be expressed in a variety of ways and it is an obvious drawback, and an additional complication, for students who may be having difficulties solving the problems, if they are then required to input their answers in a specific way, or if they are informed that their answer is wrong only because it fails to obey computer notation. Therefore, we set out to construct an evaluation procedure that would allow users to input their answers in any order. This procedure initially checks the input string for simple errors, such as mismatched brackets, and for obvious sources of error, such as very long input strings, at which point the user is asked to correct the errors or simplify their answer. The procedure then evaluates the string using an array of previously-stored variables and a wide range of mathematical functions, allowing for different ways of inputting, parts like multiplication of factors and powers. We have made some concessions to normal mathematical notation by removing the asterisk for multiplication and by programming the function keys to allow expressions with '{', '}' and the symbol 'c'. We have also allowed for the notation of sin}(x) etc but these so far are our only concessions to mathematical notation.

There are other ways too to stimulate interest by employing the dynamic features of microcomputers. We have used graphics to broaden the student's experience. Graphs of functions can be quickly sketched on the screen to give visual emphasis to what is meant by, for example, a turning point. Moving tangents have been employed to indicate stationary points and points of inflexion. Mathematical 'games' have been constructed with student interaction an important feature. This form of learning appears throughout the CAL literature. Students seem to learn when they are enjoying the material so much of what we do is intended to stimulate this learning process. Nor are such methods of learning new for Plato is reported to have said that 'Students learn best when they are at play and such learning stays in the soul.' Sprites have been constructed to aid this process of enjoyment and learning.

SOME LESSONS LEARNT

The CALM software on differentiation has been tested thoroughly now by two groups each of over sixty first year Mechanical Engineers in the Autumn terms of the academic years 1986/7 and 1987/8. We have embarked on an educational evaluation of the teaching packages under the expert guidance of Professor John Cowan, the Scottish Director of the Open University (see [3] for details). Following a detailed formative evaluation last year in which the main purpose was to gather information about the way the project was being received we have recently interviewed a dozen students to confirm the views from last year. We have also given out a comprehensive questionnaire to all the class. The interviews will continue in terms 2 and 3.

A number of important lessons have been learnt which will enable us to produce more effective software. For example, we have experimented with the worked example section and provided 'hint' screens to nudge students in the right direction through a problem. In this way we hope to build up their confidence to tackle more difficult questions. There is much more to do in the area of mathematical 'games' in which students learn in a fun way some aspect of mathematical principle. The computer as a teaching aid is here to stay and there has been sufficient genuine student interest in our experiment to justify further investigation.

Indeed, last year matched groups of Scottish students scored on average 15% better with CALM than without it in the final examination. More details on the CALM Project will be published in [4]. One student described it by saying that it was as if one had the tutor in front of you all the time. The familiarity these students find by using the computer is an important element in the education of tomorrow's graduates.

REFERENCES

1. J Renshaw et al, Maths Teach Conf, Moray House, Edinburgh (1987) to appear.
2. R D Harding, Bull Inst Math Applics, 22, 76, (1986).
3. C Beevers et al, Computers in Education, 12 to appear.
4. C Beevers et al, Int J Math Educ Sci, to appear.

COMPUTER AIDED TEACHING OF MICROELECTRONICS

C.G.Guy, M.Howarth, S.Kawar.*

ABSTRACT

This paper covers some experiences gained whilst teaching computer architecture to undergraduates. It concentrates on a self teaching package which has been developed to start the process off. The current package runs on an IBM PC and starts with a simple explanation of the difference between analog and digital representations of numbers. It progresses through logic gates to simple logic blocks like registers and adders and shows how these can be used to build up a computer. Student input is required at all stages, for instance to complete the truth tables of gates. The final part is a pictorial simulation of a simple microcomputer. The user can enter short programmes in assembly language and watch the internal working of the computer as it executes the programme. The movement of instructions and data can be followed. A variable time delay allows for different student needs. The package was written in Turbo Pascal and will run on most IBM PC configurations. It has been used as an introduction for first year undergraduates and for postgraduates on conversion courses. It is also an ideal demonstration tool for things like school open days.

INTRODUCTION

Many students embarking on undergraduate courses in Electronic Engineering, or on one of the new postgraduate conversion courses in Information Technology (ref 1), have some experience of programming computers but have no knowledge of their internal operation. The first few steps in teaching how a computer works are crucial because this subject, more than most, relies on confidence to gain understanding. Experience shows that if students are presented with a full computer architecture from the start many will mentally give up and decide they will never understand. The challenge is to present the information in an interesting fashion and in easy stages, before building up to the full architecture. The best way is to use a cut down version of a real machine so that they don't have to relearn everything from the start when moving on to the next stage. When this approach was first developed at UCL (ref 2) the processor chosen was the Zilog Z80. This is not especially complicated in its full version but is readily adaptable to a simplified teaching approach. The choice was made because of the available equipment, a set of S100 based CP/M microcomputers. The cut down version of the Z80 which was presented to the students had only two general purpose registers, two flags (carry and zero), a programme counter, a stack pointer and an ALU. The instruction set was limited to about twenty instructions ie load, store, inc, dec, in, out, add, subtract, jump (conditional) and jump to subroutine. The tasks that were given were to write simple assembler code programmes, hand code them, and then load and execute them on the real machines, emulating the simple versions. The machines were fitted with a number of I/O ports, connected to lamps, switches and a digital to

---

* Department of Electronic and Electrical Engineering, University College London, Torrington Pl, London WC1E 7JE

analogue converter. The simple routines built up to a reasonably complex task, where the value on the switches was used to set the frequency of a triangle wave output. Using this was reasonably successful but it was felt that there was a need for an even earlier stage, so that the execution of simple instructions could be observed, without the tiresome task of having to write a programme!

FIRST TEACHING PACKAGE

It was felt that the best approach was to try and use a computer with good graphical output to emulate the simple microprocessor and to display its internal working on the screen. At this time (1981) the only suitable machine which was readily available was the Sinclair Spectrum, which fortunately also used the Z80 as its CPU. A programme was written, mostly in Basic but with some assembler code routines, which allowed the user to input instruction mnemonics and then showed the movement of data within the CPU. For example an input instruction would be shown as outputting the port address and getting back the data into the 1st general purpose register. About ten other instructions were automated in this way. The user could slow down, speed up or single step the process. In this teaching package there was no facility for chaining instructions ie seeing a complete programme execute. Whilst the package worked and was generally thought to be of reasonable standard it was very rarely used. This was because of the difficulty of using a Spectrum and cassette drive (3 or 4 attempts being commonly necessary in order to load a large programme correctly) and the fact that it wasn't felt appropriate to invest in lots of Spectrums as this would be their only use. Students that did try the package out thought that it would have been useful to them at an earlier stage in their careers.

In 1986 the department invested in a large number of IBM PCs, to be used for teaching computer programming and for running applications programmes such as circuit analysis packages. It was felt that this was a good opportunity to re-introduce the type of package described above as the first step in teaching computer architecture. The IBM PC has reasonable quality graphics, the students would be used to using them because of their other coursework and we had plenty of them! Two third year students took on the task of developing the teaching package. An immediate decision was to make the whole thing more extensive and to include teaching material about the blocks eg gates, adders etc that go to build up a computer. These would then be shown as combining in a relatively straightforward way to make a simple computer. The actual computer architecture simulated is a simplified version of the 8088, the processor in the IBM PC. The 8088 is used to teach assembler code programming to the first years in this department, which was why it was chosen as the basis of this model. It is not an ideal architecture to use, having no regularity but at the simplified level this doesn't matter. The main peculiarity of the 8088 ie segmented memory addressing is way beyond the level of the model, in any case.

THE 'MICRO' TEACHING PACKAGE

The package is menu driven and starts with a choice between going through the introductory session or going straight on to the microprocessor simulation. The introductory part is further divided into sections, allowing a student to start at the level they have already reached, or to repeat particular parts. The first section in this group gives an explanation of the difference between analogue and digital representations of information. It uses an example of a loudspeaker and control knob to show how data in the digital domain is quantised. The next section deals with logic truth tables and invites the user to complete the table for a simple two input OR gate, after suitable explanations. In the current version of the package the user has to get the answer right in order to proceed. Future versions will provide assistance if needed.

The next section introduces logic gates in block form and shows how they can be interconnected. Again the user must provide some simple answers before being allowed to proceed. The three sections following this show how gates can be built up into useful functional blocks, such as registers, multiplexors and adders. In each section the user is invited to input answers to simple questions, hopefully reinforcing the message. Another section introduces the concept of the bus for interconnecting various modules. The last part explains briefly how all these elements are joined together to produce a simple microprocessor.

If a student has gone through all these sections then they should be ready to tackle the microprocessor simulation. This is presented in diagrammatic form on the screen. Included are some general purpose registers, an ALU, a flag register, a stack pointer, an instruction decoder and a memory area. The user is invited to enter a simple programme into the memory area and then watch it execute. There are about twenty five instructions which can be used and it is possible to have about fifteen programme steps. Once the programme has been entered the user is asked to specify the time delay between each step in the simulation. At present this is entered as a number of milliseconds. Future versions will be more user friendly, allowing a choice of several different execution speeds, with meaningful names.

Execution of the programme shows the address in the programme counter moving to the memory and the instruction at that address being fetched into the decoder unit. Any subsequent data is then fetched in the same way and put into the appropriate register, or straight to the ALU. Arithmetic and Logical operations are shown taking place in binary form and the flags are updated as a result of the answer. Some conditional jumps are allowed as are pushes and pops to and from the stack. If a mistake is found in the programme the user is prompted to correct it and execution continues.

EXPERIENCES OF USING 'MICRO'

The package was completed in June 1987, so at the time of writing experience of its use is somewhat limited. It has been made available during school open days, where the users were younger and more inexperienced than those originally targeted. It seems to work quite well at this level, although some details of the implementation were exposed. The main points to emerge were that the introductory part should be expanded with more emphasis placed on the later sections where the integration of the gates into systems is explained. The microprocessor simulation should be made easier to use and one particular quirk should be eliminated. This is that the programme is lost as soon as it has run once and the user opts to continue. This is particularly annoying if modifications have been made along the way and you want to review the working version. As mentioned previously there are some aspects which are not particularly user friendly, which would have to be sorted out before the package could be more widely used.

CONCLUSION

This paper has described a computer based package for introducing microprocessor hardware to undergraduates. The package is working but needs some modifications to be really useful. It could be made available to other Higher Education establishments and schools once it has been made more user friendly.

APPENDIX

The package was written entirely in Turbo Pascal and contains about 5000 lines of code. Most of the package uses the text mode of display, so will run on non-graphics screens. A question at the start determines if graphics is available and restricts the usage if it is not. Modifications to the package will probably include rewriting the existing graphics sections so that the whole thing runs in text mode. This will improve the protability of the package to other Turbo-Pascal implementations and to other machines entirely.

References

1. C.G.Guy, Electronics and Power,pp215-216,Mar 86
2. C.G.Guy, Electroics and Power,Mar 82

K:AMP Alliance for Manufacturing Productivity
A co-operative project between education and industry.

Jimm Meloy

ABSTRACT

This paper describes K:AMP; the participation of Kent State University in the Alliance for Manufacturing Productivity (AMP), a project sponsored by Autodesk, Inc. The Alliance was initiated to promote manufacturing productivity, and implement low-cost CIM (Computer Integrated Manufacturing), primarily within small companies, by transferring the technology through two year colleges. AMP is currently composed of 20 Educational Institutions throughout the USA and several high technology companies with products which contribute to manufacturing productivity. The organisation of the Alliance and specifically, the implementation at Kent State State University are described.

MANUFACTURING AND THE ECONOMY

Historically, power and wealth have been gained by those nations that efficiently manufacture and trade their goods (ref 1). Early British and other European industrialisation succumbed to American leadership in manufacturing, now challenged by Japan and others (ref 2). Some US political leaders hold that America has graduated to a post-industrial service economy, reflected by the decline in manufacturing employment from 50% of all jobs in 1950 to 20% today, and the increase in service jobs to 70% of all employment (ref 3). This decline in manufacturing capability and the use of outdated manufacturing methods in an increasingly global marketplace, is seen by some as part of the reason for the current crisis in the US economy. The project described is based on the assumption that manufacturing capability must be recovered, especially in small companies, and the technology to improve productivity must be transferred to manufacturers through educational institutions.

DAVID AND GOLIATH AND CIM

Most US manufacturing companies are small; 70% have less than 20 employees (ref 1). About 30,000 generate between $5 million and $100 million of annual business, 750 between $100 million and $1 billion,and only 260 have over $1 billion (ref 4).

CIM is the co-ordination of all engineering, production and business operations within a manufacturing enterprise. Many larger companies are improving their manufacturing productivity, often at major expense, by the partial implementation of CIM (Computer Integrated Manufacturing), namely CAD/CAM, (Computer Aided Design/ Computer Aided Manufacturing), robotics and other technologies. Smaller companies often lack the expertise or finances to investigate or

Kent State University, 4314 Mahoning Avenue, Warren, Ohio 44483, USA.

develop even a partial CIM implementation, employ a manufacturing engineer, or install a dedicated CAD/CAM system.

CIM, THE PC AND THE ALLIANCE

Developments in microcomputer hardware and software in the last two years now make it possible to implement CIM at low cost on a personal computer (PC) by integrating application programmes. The Alliance for Manufacturing Productivity (AMP) has been formed to develop and transfer this technology to the manufacturing community and primarily smaller companies, unable to afford in-house expertise. The Alliance is currently composed of a network of 20 educational institutions throughout the USA and several high technology companies, lead by Autodesk, Inc, a leading manufacturer of PC based CAD software.

OTHER TECHNOLOGY TRANSFER PROGAMMES

Manufacturing productivity and the transfer of technology has been addressed by others. Some examples are:
At Federal level, the National Bureau of Standards (ref 5) and the National Science Foundation sponsor showcase CIM implementations (ref 6). At State level, Michigan has constructed the Industrial Technology Institute (ITI) (ref 7). At Regional level, the Cleveland Advanced Manufacturing Program (CAMP) is typical of joint local industrial and educational co-operation (ref 8). CIM education is sponsored by professional organisations like the Society of Manufacturing Engineers (SME) (ref 9). CIM research and showcase installations are found in many universities, for example, Bringham Young University (ref 10), and the University of Rochester (ref 11). Many of these focus on larger installations, basic research and on four year progammes.

ALLIANCE FOR MANUFACTURING PRODUCTIVITY

The Alliance for Manufacturing Productivity (AMP) was initiated in April 1987 with the purpose of promoting manufacturing productivity primarily within small companies. The educational institutions and sponsoring high technology companies have agreed to share their resources. Sponsors are responsible for contributing software, hardware and consulting services, and the colleges are responsible for integrating and showcasing the software, developing courses, and contributing facilities and faculty to transfer this technology to the small businesses. The CIM laboratory developed by Brigham Young University has been adopted by the Alliance as a model.

EDUCATIONAL MEMBERS

Colleges from Arizona, California, Conneticut, Georgia, Indiana, Louisiana, Maryland, Michigan, Missouri, New Jersey, New York, North and South Carolinas, Ohio, Oklahoma, Tenessee, Washington and Wisconsin are currently members of the Alliance. Two year colleges were selected since they generally offer practical and vocational orientation, locations near major manufacturing centres, flexible scheduling and a close relationship with the local community.

Each institution retains control over its own programme and technology transfer to area industry, typically by development of credit and training courses, a showcase CIM laboratory and joint projects. Alliance members co-operate by sharing course, curriculum, hardware and software integration and evaluation information and developing different aspects of CIM. In the case of Kent State University, this is Finite Element Analysis, Simulation, Technincal Documentation and availability of a "2+2" degree for students who wish to complete a four year degree. In many instances, the aims of the Alliance align with programmes already under development. There is a wide variation in institution size, expertise and facilities.

SPONSORING COMPANIES

Autodesk,Inc, a leading CAD software company, whose products include AutoCAD and The Engineer Works, is the major sponsor of the Alliance and has contributed over $400,000 in software to the program. Other contributing companies include Encographics Inc, Kinetic Graphics Systems, Light Machine Corporation, NC Microproducts, Roland DG, Synthesis and Systems Modelling Corporation. Currently, AutoCAD is the major software used on the project and is ideally suited to the low cost implementation of CIM for several reasons, namely:

it is the most widely used CAD software, and effectively the defacto standard for microcomputer based CAD.

it has an open architecture, which allows easy customisation.

it operates under IBM PC/DOS enviroment, the defacto microcomputer standard, offering software and hardware independence and hardware customisation and potentially allowing it to operate in conjunction with other software using that enviroment.

over 500 third party application programs which run under, over or in conjunction with AutoCAD are already available. It is by the integration of these programs that the implementation of CIM can be achieved on a PC.

OTHER CONTRIBUTORS

Research universities, government and professional organisations, including Brigham Young University, the National Bureau of Standards, the Society of Manufacturing Engineers and the National Council for Vocational Education have confirmed their support of the Alliance.

K:AMP - Kent State University: Alliance for Manufacturing Productivivity Project

Kent State University is located in a major manufacturing area of North East Ohio, and joined AMP in November 1987. The University offers two year technology degrees at its regional campuses, including Trumbull Campus where the Alliance program is concentrated, and four year technology degrees, including a "2+2" at the Kent campus. The Alliance project at Trumbull has taken several forms:

Development of an integrated manufacturing curriculum and courses

Implementation of software which form part of CIM, namely CAD/CAM, Finite element analysis, Simulation and Technical documentation and presentations.

Development of a series of joint projects with local companies

Organisation of an advisory board consisting of area educators and industrialist.

Organisation of a 2 day conference to showcase current CIM hardware and software with presentations and workshops by recognised leaders in the CIM industry.

Future plans include:

Development of a showcase CIM laboratory

Joint projects with area industry have been undertaken by employees of area companies attending courses at the campus and include development of:

two integrated CAD/CAM systems for production and toolmaking.
a series of parametric CAD libraries for die design.
a series of CAD generated colour coded technical documents.
a simulation model for a factory floor reorganisation.
a set of finite element analysis models for specimen testing
a series of computer generated CAD and CIM course presentations.

FUTURE OF THE ALLIANCE

A computerised network for the exchange of information between colleges is being developed and a working PC-based CIM flexible manufacturing system developed by the Alliance sponsors will be demonstrated at a manufacturing conference in April. Additional sponsors and colleges, including an international contingent, may join the Alliance.

REFERENCES

1. J. Oakey, Co-operative Education and Industry programs to enhance Productivity, 4th International Forum on Micro-Based CAD, North Carolina State University, Raleigh, September 1987.
2. D. Halberstam, The Reckoning, Random House, 1986
3. S. Cohen, J Zysman, The Myth of a Post-Industrial Economy, Technology Review, 55, Feb/Mar 1987
4. C. Machover, MicroCAD Trends 1980-1990, 4th International Forum on Micro-Based CAD, North Carolina State University, Sept 1987.
5. R. Penn, National Bureau of Standards, Alliance for Manufacuring Productivity Meeting, SME, Detroit, November 1987
6. S. Barlas, Down and Out, Managing Automation, 35, February 1987
7. J. Jacobs, Industrial Technology Institute, Alliance for Manufacturing Productivity Meeting, SME, Detroit, November 1987.
8. CAMP Conveyer, Cleveland, Ohio 44115, V,II, Winter, 1987.
9. H. Hales, Understanding CIM, SME, Dearborn, Michigan, August 1987
10. D Allen, T. Moon, Universal N/C Control Codes in the CIM Mini-Lab, CAM Center, Brigham Young University, December, 1986.
11. T. Check et al, Production Automation Project, University of Rochester, April 1978

EVALUATING EDUCATIONAL TECHNOLOGY

Eugene G. Kerr EdD *

ABSTRACT

As the explosion of microcomputers in schools continues to expand the need for an evaluation model has been expressed by educators and educational administrators. Since Learn-Laboratories are one of the fastest growing segments of the use of microcomputers into the K-12 market, it has been selected as the first area in which to develop an evaluation model. The first use of this Learning Lab Evaluation Model was to measure the products of six US vendors which resulted in Computer Curriculum Corporation and IBM scoring the highest on the Evaluation Model.

INTRODUCTION

Savant Inc. an Educational Technology firm located in Bellevue, Washington often is asked to evaluate vendors of computer based educational products. This lead Savant to survey a number of school districts and other educational groups to obtain the baseline data for an Evaluation Model to be used in evaluating vendor or self developed computer based educational products. This model (Figure 1) was put together in mid 1987. In September 1987 it was used to evaluate seven vendors for an educational client of Savant's The results of this evaluation are found in Figure A. This paper presents the model including the rationale behind it and the results obtained in its first application.

EVALUATION MODEL DESCRIPTION

The following model for K-12 Instructional Systems (Learning Laboratories) (Figure 1) was developed based on the following

- o Interviews with 50 school districts over 25,000 students
- o Interviews with 50 school districts from 10-25,000
- o Interviews with 50 school districts under 10,000
- o Interviews with 10 State Departments of Education
- o Interviews with 10 University Departments of Education

* Savant Inc. 515 116th Ave N.E. Ste 107 Bellevue,Wa. 98004

K-12 INSTRUCTIONAL SYSTEMS
EVALUATION MODEL
GENERAL (100 POINTS)

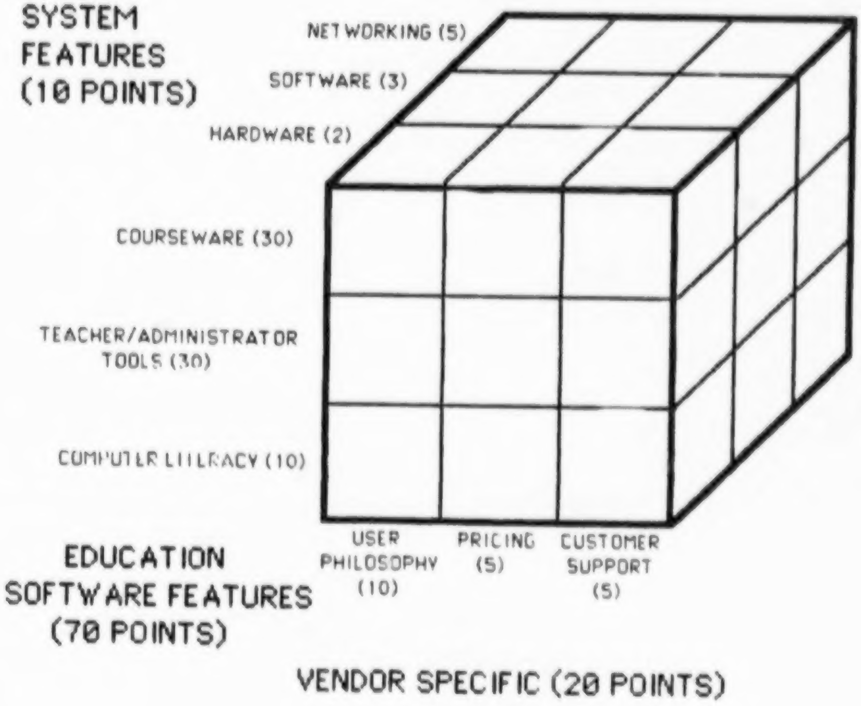

SYSTEM FEATURES (10 POINTS)
NETWORKING (5)
SOFTWARE (3)
HARDWARE (2)
COURSEWARE (30)
TEACHER/ADMINISTRATOR TOOLS (30)
COMPUTER LITERACY (10)
EDUCATION SOFTWARE FEATURES (70 POINTS)
USER PHILOSOPHY (10)
PRICING (5)
CUSTOMER SUPPORT (5)
VENDOR SPECIFIC (20 POINTS)

FIGURE 1

GENERAL MODEL (Figure 1) 100 POINTS

This was the summary model designed for the evaluation and was given a total score of 100 points. It summarized the three major areas found to be appriate to Learning Labs in the K-12 Instructional Systems Areas. The three major categories that make up the model along with their point totals are:

1. System Features 10 Points

   This area included the hardware, software and networking products that made up a vendors offerrings.

Each sub-category was further refined into its elements and these were used to produce the final scores that provided the evaluation.

2. Education Software Features 70 Points

   This area is by far the largest category and the one that was indicated as the most important to the districts interviewed. It was further broken down into:

   - o Courseware 30 Points
   - o Teacher/Administrator Tools 30 Points
     - o Computer Assisted Instruction (CAI)
     - o Computer Managed Instruction (CMI)
     - o Testing
     - o Other Tools
   - o Computer Literacy 10 Points
     - o Languages
     - o Productivity tools and Utilities
     - o Other Activities

3. Vendor Specific Features 20 Points

   This area dealt with vendor relationships and support.

   - o The vendors User Philosophy 10 Points
   - o Pricing 5 Points
   - o Customer Support and Maintenance 5 Points

   Again each of these categories was further refined in order to obtain an accurate evaluation.

The development of the Evaluation Model for Learning Labs resulted in some interesting aspects:

1. Networking was the most important system feature.
2. Teacher/administrator tools were considered to be as important as the Courseware itself.
3. Teaching programming was second to the use of tools such as word processing, spread sheets, etc.
4. The general attitude of the vendor was more important than maintenance and customer support.
5. Pricing was not seen as significant in the decision to buy a particular vendor's product.

RESULTS OF APPLYING THE EVALUATION MODEL

Savant as part of a study for one of its Education clients applied the Evaluation Model to seven vendors which were: (1) IBM,(2) APPLE, (3) Computer Curriculum Corporation (CCC) (4) Educational Systems Corporation (ESC), (5) Prescription Learning (PRLNG), (6) Tandy and (7) WICAT Systems.

The results are found on the following chart (Figure A)

K-12 INSTRUCTIONAL SYSTEMS EVALUATION MODEL GENERAL (100 POINTS)

VENDORS	IBM	APPLE	CCC	ESC	PRLNG	TANDY	WICAT
SYSTEM(10) FEATURES	6	3	5	4	5	4	5
HW(2)	2	1	1	1	1	1	1
SW(3)	2	1	2	2	2	2	2
NW(5)	2	1	2	2	2	2	2
EDUCATION FTS (70)	34	22	40	27	26	27	35
CW(30)	18	12	20	15	14	15	18
TOOL(30)	12	5	15	10	10	10	15
CLIT(10)	4	5	5	2	2	2	2
VENDOR SPEC (20)	8	5	6	6	7	7	6
USER(10)	3	2	2	3	3	3	[illegible]
PRIC(5)	2	2	1	1	1	1	[illegible]
SUPT(5)	3	1	3	2	3	3	2
TOTAL(100) VENDOR	48	30	51	37	38	38	46

FIGURE A

The Evaluation resulted in some interesting findings:

1. The vendor with the longest time in the Learning Lab market (CCC) came out with the highest score.
2. IBM who is a recent entry into the Learning Lab market did exceptionally well.
3. Even though several vendors have invested heavily in Courseware, they have only a small percentage of what is required.
4. All vendors were weak in the area of CMI.
5. Pricing for a commonly defined product ranged from $50,000 to $125,000 and did not appear to be a major factor in the decision to buy.

COMPUTERIZED ACHIEVEMENT MANAGEMENT SYSTEM (CAMS)

Gerald A. Buckalter*

ABSTRACT

In the elementary schools of America, there is a need to improve the standardized achievement scores in both reading and mathematics. The traditional approach to instruction had to be changed. The advent of the computer has provided schools with the ability to manage data in such a way as to enable instruction to be delivered more effectively.

The Computerized Achievement Management System (CAMS) is one such system. Spreadsheets compile and analyze data on student achievement. This makes it possible to maintain an ever changing series of instructional groups based upon precise levels of actual achievement. Motivation and rewards can now be provided for student efforts and accomplishments. Communication amongst teachers, parents and students is of the ultimate importance. This is aided by moving data from spreadsheets to word processed form letters via copy and paste. Perhaps most important is the ability to analyze each of the potential factors which may impact on student academic success and failure. This is now possible with relational data bases and the Hypercard.

PROBLEM

The traditional approach had been to have teachers conduct instruction in all subjects with a homeroom group of students. These teachers had both areas of personal strengths as well as weaknesses. Student of varying abilities were grouped within the classroom for instruction in one or both of the above basic subject areas. The textbook was the tool designed to aid the grouping process as well as a vehicle to aid in instruction. This instruction was conducted with students of varying levels of achievement. It was a limiting factor in effective instruction.

This resulted in bored high achievers and frustrated low achievers. Classroom management seriously suffered from all these structural problems causing strain on the dedicated master teachers and concern for the academically oriented parents.

SOLUTION

One excellent way to instruct students is for the teacher to conduct instruction to a group of students who are at the same level of achievement and at similar levels of ability. This enabled the teacher to customize the methods and techniques which proved to be most effective for that particular group.

*Elementary Principal, East Ramapo Central School District,
Spring Valley, NY 10977

The materials of instruction underwent daily examination by the teachers who made periodic adjustments and alterations based upon what demonstrated actual effectiveness. These changes slowly became institutionalized. There was now a sharing of insights amongst teachers of the same type of groups on different grade levels.

INITIAL PLACEMENT

The first step in accomplishing this was to utilize all of the students on a grade level as the pool from which to create instructional groups rather than a homeroom teacher attempting to do the same with only the students in his or her class. The "grade level" groupings of students made it possible to establish relatively homogeneous sets. Each homogeneous group was assigned to each of the teachers on a grade level. The criteria utilized for this initial grouping were the achievement scores on both the Iowa Test of Basic Skills and the New York State Pupil Evaluation Program. In reading, each teacher was assigned two distinct reading groups: each of a different level. Thus on a grade level with five teachers, ten instructional groups were created. Three different reading programs geared to the high, average and low achievers, respectively were utilized. In math, each teacher received a single instructional group. The time on task contact with the teacher every student received, was now the entire period, as opposed to the partial contact under the homeroom grouping system.

The results of the composite Math scores for the Iowa Test of Basic Skills and the New York State Math Pupil Evaluation Program were entered on successive Excel spreadsheets. The program then sorted each into rank order distributions which were compared and then used to create an initial set of instructional groups. Each group contained students of similar levels of achievement. The same process was utilized for reading.

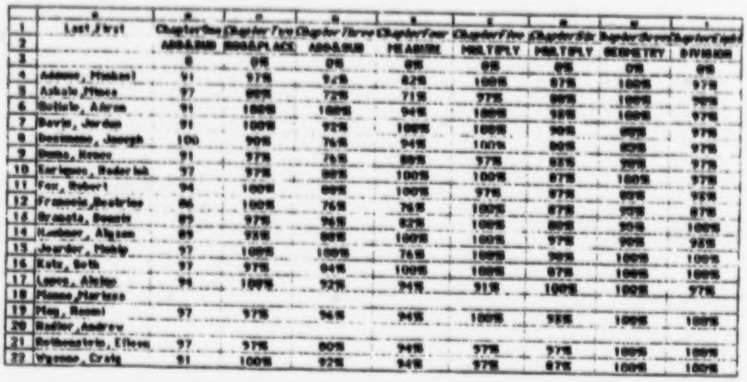
DAILY SCHEDULE

The second step involved a radical changing of the daily school schedule to provide blocks of time across each grade level for instruction in mathematics and for reading. During these blocks of time, students would move to the classroom to where their group was being instructed. In the second year of the program, the two reading groups compromised the homeroom so that the only movement between classes occurred during the mathematics period. The school schedule was created without the assistance of the computer.

REGROUPING

The third step involved establishing a procedure whereby the classroom teacher and the administrator would periodically meet and evaluate the results of ongoing classroom test results. Throughout the year students demonstrating a high degree of achievement could be moved to the next higher instructional group as well as the opposite for students experiencing failure. This proved to be an exciting stimulant to our students. Now the level of achievement and the rate of learning were limited solely by a student's inate ability and the level of effort he or she was willing to exercise.

The following spreadsheet illustrates how information was compiled, stored and analyzed by both the classroom teacher and administrator.



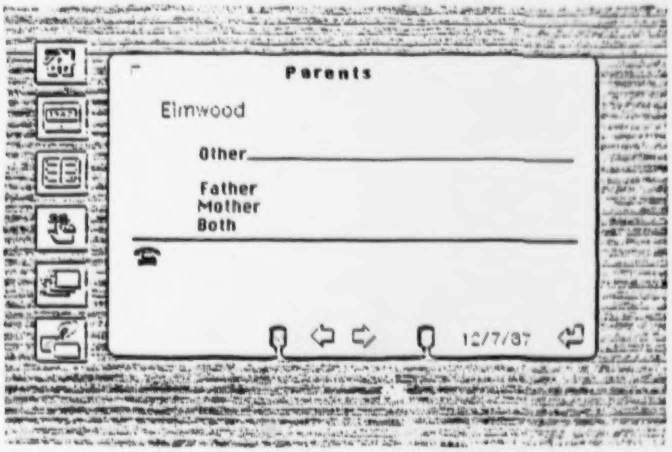
COMMUNICATION

The fourth step involved communication. The more immediate the feedback, the greater the reinforcement. Every time there was a change in a student's instructional group placement, not only was the student informed but also a letter was immediately sent to the parents explaining the change, indicating from what teacher to what teacher, also listing the actual student scores that formed the basis for the movement. These form letters were created utilizing Word 3.01. The letter refers to the students recently administered test results and provides space for the appropriate row on the spreadsheet to be copied and pasted to the letter. In this manner, the parent could see one of the basic factors utilized in making the change of placement.

Personal explanations regarding the reasons established by both the instructional teacher and administrator were shared with the parents by the classroom teacher via follow up telephone conferences. Students who experienced frustration by being placed in the next lower group were given the opportunity at a slower pace to be exposed to the skills in a much more thorough fashion. They were higher motivated by finally achieving success. This has proven to be quite a motivator. Many of these students, having worked their way through skills which were difficult to obtain, then began to demonstrate great success which enabled them to move back to a faster moving group.

ANALYSIS OF SUCCESS & FAILURE

A long range project which may prove to be most significant is the obtaining of data on all of the possible factors which may have a cause and effect relationship with the student's actual academic success in reading as well as mathematics. It is possible, through the use of a relational data base and/or the Hypercard, to accumulate stacks of information on each student and then analyze the data for insights or relationships. There is a breakdown in our district by grade 5 of the Cognitive Ability scores into verbal, quantitative and non-verbal. The computer can conduct periodic comparisons of the verbal aspects of one's ability with that individual's ongoing achievement in reading. It can compare the quantitative with the math. We can also look at the parent, legal guardian, foster parent, etc. situation at home, as well as the student's behavior in school. It may be possible to determine much more precisely why students function at fast, slow or average levels in reading as well as math. This would further enable the school to respond by institutionalizing the factors that led to certain student's successes and making changes where possible in those factors that caused failures. The following are samples of such data base stacks.



Parents

Elmwood

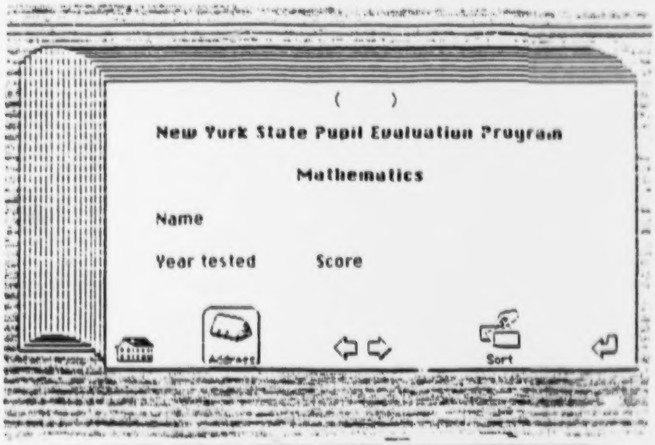
Other

Father
Mother
Both

☎

12/7/87

What is the home situation? Parents, guardians, foster parents?



( )

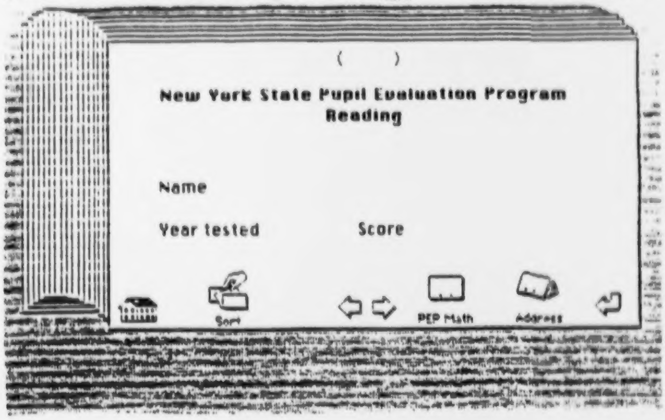
New York State Pupil Evaluation Program

Mathematics

Name

Year tested Score

Achievement scores on New York State Mathematics Test



( )

New York State Pupil Evaluation Program
Reading

Name

Year tested Score

Achievement scores on New York State Reading Test

TEACHING PROGRAMMING AT A DISTANCE

A. C. Jones[1]

ABSTRACT

This paper reports on an empirical study of novices learning two different programming languages through distance teaching: SOLO, a LOGO like language designed for psychology students and an assembly language. Examples are given of the instructional design of the programming manuals and also of three different problems which learners experienced: flow of control, difficulties in knowing where to start on a problem and the identification and use of appropriate programming plans. The paper also looks at the problems the students had in interpreting the text and relates these to the instructional design of the manual. It concludes with some recommendations for good practice in teaching programming at a distance and suggests that much of the work that needs to be done is in making implicit knowledge manifest.

INTRODUCTION

Students of the Open University study part time, at home, using mainly correspondence texts but also other media, with limited face to face tutorial contact. Programming is a component of several university courses. This study looked at students learning four languages designed specifically for novices in order to gain a detailed understanding of some of the difficulties which novices have. Such an understanding can then be used in improving instructional design. Only two of the languages will be considered here. They are:

1. Learning assembler using DESMOND, a small microcomputer which is part of a short course for teachers on microcomputers. Subjects were given a DESMOND, a reference card and the practical book, most of which is concerned with teaching DESMOND's assembly language.
2. SOLO. SOLO is a LOGO like language taught to cognitive psychology students to introduce them to Artificial Intelligence (AI) (ref 1).

INSTRUCTIONAL DESIGN OF DESMOND AND SOLO

All the practical activities for DESMOND are contained in the practical book, which is the document used in this study. DESMOND was designed to make its workings as visible as possible, and conceptually simple. Much of this is achieved by physical layout, where functionally different devices are separated, and there are mode keys to choose between monitor mode, assembly mode, and run mode. The display is divided into three segments which give different information. For example, in monitor mode the address of a location and its contents in denary and binary are displayed. In assembly mode the display typically shows the line of the program in the first segment, the instruction in the second, and a digit in the third.
SOLO consists of a *data-base* (consisting entirely of triples) and *procedures* which act on the data-base. The intention was to make SOLO as easy as possible for novices to learn, by using such design principles as those of du Boulay, O'Shea and Monk (ref 2). These principles will not be described here, but the basic idea is to provide a conceptual model which is simple, consistent and transparent. The SOLO practical book, - which is the main teaching guide, has a clear metaphorical description of how the language works, and error messages reflect this, Concepts are introduced by analogy with everyday objects or ideas with which users are familiar, - for example the analogy of an automated telephone directory is used to introduce the database. SOLO also aims to give the information required in a way which is accessible to novices, but which avoids confusing the user with unnecessary details. As far as possible flow of control is made explicit and the system ensures that programs are syntactically correct. The different teaching styles of the two practical books reflect the differences between the languages and the curricula. DESMOND aims to

---

[1] Institute of Educational Technology, Open University, Milton Keynes MK7 6AA

give teachers a grasp of the princicples of microcomputers whereas SOLO introduces cognitive modelling using AI techniques. The DESMOND practical book guides students through at quite a detailed level, and includes activities (often keying in programs) where a three column format is used: the first column gives the keypress, the second shows what will appear on the display, and the third gives an explanation. The SOLO practical book however discusses more abstract concepts such as symbols, procedures etc,. It shows how SOLO's data-base can be changed by using procedures, and then goes on to introduce variables, iteration and recursion.

OUTLINE OF STUDY AND METHODS

20 subjects worked through the DESMOND practical book which is divided into 7 chapters although only 8 completed the whole book. They filled in comment and log sheets, attempted all the set exercises, and were interviewed in pairs every two weeks to discuss their work and any problems they had.

11 subjects were asked to think aloud as they worked through the SOLO practical book, attempting all the exercises. They each had a computer terminal. Both their verbalizations and their interactions with the computer were tape recorded using Cyclops, a device developed at the University enabling data and voice to be recorded simultaneously. None of the subjects had any previous programming experience.

RESULTS

Of the programming tasks among the exercises attempted by the DESMOND subjects, 63 programs were marked as incorrect and anlaysed for error which were then categorised. The first three categories are given in table 1 below, and these categories are also used to look at the more qualitative data from both the DESMOND and the SOLO study.

Table 1: categorisation of errors in DESMOND programming tasks

1	Flow of control	43%
2	Missing/incomplete code	16%
3	Missing or inappropriate plan	12%

1 Flow of control

Flow of control errors are well known in the programming literature (ref 3) and will only be discussed briefly. In DESMOND the errors changed as the programming tasks became more complex. Early incorrect programs often contained an additional jump back to the beginning of the program, but later programs contained different errors: control "falling through", unreacheable code, jumping back to the wrong place, jumping to the next line and complex unstructured code.

SOLO forces the user to specify flow of control for both branches of the conditional, and there were fewer problems here. However, early on subjects confused the two control statements CONTINUE and EXIT[2], and in the first exercise using these structures they had difficulties working out the logical form of the problem: "If A or else B and C present do..." Having done this, they still had problems trying to achieve this using SOLO.

2. Not knowing where to start on a problem

The DESMOND subjects were often unable to write complete programs. When looked at in conjunction with subjects' comment sheets and interviews a more general problem emerges of subjects not knowing where to start on a problem. In particular they had difficulties in writing programs from scratch. Early exercises requiried modifications to existing programs or filling in gaps, but later exercises required the subjects to write complete programs which they found difficult, although they could understand the problems in the text and the answers given to the exercises. Chapter 4 contained the most programming problems and was the hardest. One student commented on how:

---

[2] CONTINUE takes control to the next instruction and EXIT terminates the activation of a procedure.

"The instructions failed from p165 onwards to show me how to write a program."

The different categories are not totally independent. For example flow of control problems prevented some subjects from getting very far as they did not know how to fit the code together.

Unlike DESMOND the SOLO manual does not require students to write many procedures from scratch, but they did have problems on the first exercise of this kind, as described above. At points like these, like DESMOND subjects they would say they did not know where to start, but they did usually manage to write a procedure, even if it did not do what they wanted.

3. Identifying and using appropriate plans

Research at Yale University and elsewhere has suggested that programs can be viewed partly as collections of plans, - of stereotypical sequences (ref 4). Analysis of the DESMOND programming exercises revealed that students need to use 21 plans to complete them. In this study plans are defined as two or more instructions, which though not necessarily contiguous, together achieve some function. Plan knowledge also includes knowing when to use the appropriate plan and how to weave them together to form a program. Such plans are not taught explicitly in this way, and the exercises where students were least successful were those requiring quite complex plans which had not been given to them directly, or requiring a combination of plans.

The SOLO exercises were not analysed in terms of plans, but it was clear that many of the novices studied had not got to the stage of having acquired plans. They would therefore look at examples in the text but often had little understanding of the function of such example programs, e.g. they didn't know what SOLO code would achieve a filter or a disjunction. The clearest example of this is the difference between three subjects who were studied in detail on their first programming problem. All three used two procedures given as an example in the text as models, but only one subjects was successful, because she was clear about what each of the examples in the text achieve, i.e. she had acquired the appropriate plans.

Dealing with the unexpected and actively interpreting the text

Another problem which both DESMOND and SOLO users had concerned how they processed the text as well as their understanding of the content. This is the issue of how to deal with unexpected events, and is particularly pertinent to distance teaching. Because the DESMOND text accounts for events in such detail any variation from what a subject expected to happen caused some concern; and individuals' tolerance of this varied considerably. For example, one subject found that the test routine wasn't as expected, and didn't know whether it was his problem or not:

"...so if it says something different I begin to question whether I'm doing the right thing or whether the text is slightly wrong, or the machine is wrong.",

and later a similar problem occured again where his display differed from the example given. There are similar examples further on in the curriculum in chapter 3, where there is a minor misprint. Here again, people coped quite differently with this, and finally in chapter 4, a particular section of text was often misread and led to problems.

Although the SOLO text does not have such a detailed step-by-step approach, the same problem did occur. One subject spent a considerable amont of time trying to find a solution to a problem set in the text. In fact he had already suggested the only possible solution, but believed that this could not be correct, because it conflicted with his incorrect but persistent mental model. He had misunderstood the text in a way that fitted his own beliefs.

DISCUSSION AND CONCLUSIONS

Flow of control is a well known problem for beginners, and the design of SOLO had anticipated such problems and attempted to alleviate it. This attempt was not totally successful, although subjects' difficulties were not as persistent as were those of the DESMOND subjects.

Both groups of subjects had difficulties in creating their own programs, but the problems experienced by the DESMOND subjects were much more severe. Many of them felt that their understanding was not at a very deep level. Perhaps such problems are not too surprising however in that the process of designing and coding a program had not been explicitly taught and the subjects' comments suggest that they lacked explicit guidance in this area. In this aspect the text is not dissimilar from many other courses where students are expected to abstract design principles from the examples given, but one additional problem for distance learning texts is the lack of space for examples. The DESMOND practical book often contains only one or two examples of how a new instruction is used in a problem, and subjects commented that they needed more practice in similar problems before trying to apply what they'd learnt.

This relates to subjects' problems in abstracting plans. The data in this study suggests that many novices are not able to abstract plans from examples they are given, although the most successful do.

Finally the very structured approach often adopted in distance teaching may itself lead to problems in this area. Although the text can try to clearly state the steps that should be followed, - it can never be totally unabmiguous. Desmond and SOLO students often misinterpreted the text. The author cannot therefore be assured that a piece of text will be understood by the learners's active interpretation in the way that the author intended. It seems that where a text is so structured and detailed, learners rely on it heavily, and when things do go wrong recovery may not be easy. Some of the least confident DESMOND subjects put too much faith in the text, and blamed themselves when things went wrong.

What then can be done? Much of the work that needs to be done concerns making implicit knowledge manifest. The following recommendations are made:

1. The process of writing a program needs to be taught explicitly, involving understanding the problem, design, using plans, coding and debugging.
2. The 'plans' used in working through an instruction manual should be enumerated and explicitly taught and indexed.
3. Flow of control needs to be taught directly.
4. A large number of examples need to be provided of similar problems, the ways in which they are similar needs to be made clear and the examples should be linked to the plans.

In addition careful thought needs to be given to very structured texts. It needs to be recognised that students are active learners and will misinterpret text. They need to be provided with tools for discovering their errors and recovering from them.

REFERENCES

1. Eisenstadt, M., SOLO: Units 3 & 4, D303, Cognitive Psychology, Open University, 1978
2. du Boulay, B., O'Shea, T., Monk, J. The Black Box inside the Glass Box: presenting computer concepts to novices. I. J. Man-Mach. Studies, 1981, 14, 237-249
3. Green, T.R.G. Programming as a Cognitive Activity in Human Inteaciton with Computers (eds) Smith, H.T. and Green, T.R.G., Academic Press, 1980
4. Ehrlich, K. and Soloway, E. An empirical investigation of the tacit plan knowledge in programming. New Haven Conn. Tech Report 82-236 Dept of Computer Science, Yale University, 1982

PLUGGING THE CLASSROOM INTO THE COMMUNITY: COMPUTER NETWORKING IN A MIDDLE SCHOOL

V.E.Baer*.

ABSTRACT

Since the fall of 1985, the small community of Boonsboro, Maryland, USA, has participated in a computer network project. Thirty-two networked computers and one high-speed printer in the area middle school have afforded students, teachers, and the community a unique educational opportunity.

Use of the network has helped to promote word processing as part of content area instruction. It has helped to enhance basic skill instruction in the special education program. It has facilitated enrichment opportunites for talented and gifted students. It has enriched the science program with valuable simulations. It has promoted technological enthusiasm among teachers. Most important, it has been the site for numerous activites linking local, state, and worldwide communities.

INTRODUCTION

Since the fall of 1985, the small community of Boonsboro, Maryland, USA, has participated in a computer network project sponsored by IBM and the Maryland State Department of Education. Thirty-two networked computers and one high-speed printer housed in the area middle school have allowed students, teachers, and community members to experience a unique educational opportunity.

CURRICULAR TOOL

As a tool to support school curriculum the computer network has helped to promote word processing as part of content area instruction. All 530 students in the school are taught keyboarding and word processing skills during the first grading period of the school year. Students meet twice a week for two twenty-minute sessions on the network to learn key locations, to practice correct typing habits, to build keyboarding speed to ten words per minute, and to become familiar with the basic functions of a word processing program: entering, inserting, deleting, and moving text; formatting, saving, and printing documents.

For the rest of the school year, students and their content area teachers schedule time in the computer lab for word

---

*Director of Learning Resource Center, College of Education, New Mexico State University, Las Cruces, New Mexico, USA 88001.

processing assignments. Science students write lab reports about experiments they've done; music students write research reports on composers; language arts students write many compositions, letters, and book reports; and social studies students take essay tests, write history and geography reports, and complete information exchanges.

The computer network has also been used to enhance math, reading, and writing skill instruction in the special education program. Students simply select their math or reading programs from easy-to-read menus (no floppy diskettes required), type in their names, and begin a lesson where they stopped during the last class session. Students enjoy working at their own pace to complete lessons assigned for their skill needs. Teachers use the built-in management systems in the programs to follow their students progress, select appropriate lessons, and assign homework.

Special education students enjoy doing writing assignments now because their work looks professional and their teachers don't have to deciper messy handwriting. Time normally spent avoiding a writing task is now spent in concentrated effort; students are eager to see their printed compositions and share them with peers and teachers.

Gifted and talented students use the computer network to prepare for advanced placement examinations and participate in enrichment activities in language arts and social studies. Seventh grade students who compete in the Johns Hopkins Talent Search in mathematics prepare for the qualifying SAT exam using a software package installed on the network.

Seventh and eighth grade gifted and talented students use the word processing program to create reports, write letters, and exchange information with students across the state. These exchanges have fostered friendships and a continuing desire to learn more about other communities.

Science teachers use the computer lab to expose students to science simulations impossible to duplicate in the classroom. In their earth science unit, students learn about plate tectonics as they watch simulations of earthquakes at their computers. They watch a reenactment of the Mount Saint Helen's disaster in a program about volcanoes. Later they write reports on the word processor describing what they learned during the simulations.

INSERVICE TOOL

As a tool to support inservice instruction, the network has encouraged technological enthusiasm among teachers. For example, they have developed and improved their typing and word processing skills. In a workshop prior to the opening of school in the fall, faculty are taught how to use the keyboarding and word processing programs on the network.

Then, during student instruction time and during planning times, teachers use the lab to improve their skills and generate documents useful for instruction.

Teachers have matched software applications with content area curricula in numerous inservice workshops. As software becomes available for the network, appropriate faculty members are invited for one of two activities. They may be offered time to preview software independently and to evaluate its utility in their subject specialities. Alternately, they may attend a workshop in which they see the software demonstrated; they learn to use it; and they meet in subject area departments to evaluate its utility.

Teachers have tracked their students' performance in math and basic skills with managed software packages. After receiving inservice instuction with these packages, teachers are able to (1) pretest students in a skill area, (2) identify appropriate instuctional units, (3) assign pertinent homework, and (4) assess student and class progress.

In evaluations of various inservice activities and of the computer lab itself, teachers have offered testimonials to their developing confidence with computers as supportive instuctional tools. According to individual teachers, computers "allow me to spend more time working with individual students", "are a real motivator for students who've lost interest in a topic", and "are a colorful alternative to textbooks and worksheets."

COMMUNICATIONS TOOL

As a link to local, state, and worldwide communities, the network has been a site for numerous activities. Adults from local communities have used the computer lab for keyboarding, word processing, and thinking skills instruction. They have applied the instruction to personal growth, to job skills, and to support of their children's instruction.

The computer lab has been used to generate a monthly school newsletter to parents. Parent volunteers spend several days in the lab composing, editing, and revising articles about school events. When the text is finally laid out and printed, it is sent to all of the middle school's parents. Frequently, the newsletter acts as a survey tool to encourage greater parent participation in school programs.

The network facilitated modem correspondence and a cultural exchange among students in two diverse counties across the state. Two groups of students first collected information and composed reports in the lab about people, places, and events unique to their communities. The students exchanged their reports via modem in the computer lab. For the remainder of the school year, the students exchanged personal information via modem as pen pals. The pen pals met in an end-of-year campout activity.

The computer network helped students and teachers follow national and global news with a modem-updated current events program. Each week, teachers and students took a quiz whose questions were drawn from the articles in a national news magazine. Participants learned to read the magazine more effectively, and a friendly competition developed among students to try and answer the most "bonus" historical questions.

This paper describes a sample of activities which have succeeded in the computer lab. The network has changed the face of the learner in this small town: from passive receptor to active participant, from school-age child to curious adult, from culturally isolated to globally aware community.

RETROSPECTIVE CONVERSION: THE PROCESS AND PRODUCT OF EXPANDED LIBRARY/MEDIA RESOURCES

E. K. Browning*

ABSTRACT

Almost 3,000 pupils use the libraries in Henrico County's high schools every day. The information needs of the students are met in a variety of ways. However, existing resources of the high schools and local colleges are frequently inadequate to meet student requests. To expand access to available materials countywide, a decision was made to establish a database of all the materials in the high school libraries, and to form a network with the existing database of the Henrico County Public Library collection.

Following conversion of the high schools' collections into machine-readable format, the data was loaded into the mainframe which already houses the database of the Henrico Public Libraries' volumes, thus creating access to materials well beyond the financial or physical capabilities of any one school. Each high school now is developing specialized collections so that expensive reference materials need not be duplicated but are available to each student or teacher through the online capabilities of computer terminals. An interlibrary loan system facilitates sharing these resources.

RATIONALE

An average of 350-400 students use the libraries in each of Henrico County's seven senior high schools each day, totalling almost 3,000 pupils. These students have information needs in the areas of American, British and world literature, history and social sciences, engineering, electronics, and numerous other subject areas. The information needs of the students are met in a variety of ways: school libraries, public libraries and college libraries. Existing resources of the senior high schools and local colleges are frequently inadequate to meet student needs, or if adequate, unknown to the student.

What was needed was one source which would tap the resources of all the senior high schools as well as Henrico County Public Library. In order to accomplish this, data from school libraries needed to be converted to a machine-readable format in order to establish a unified database. The result was a network of resources expanding beyond the confines of each school library to meet the requests of students, teachers, and administrators. In addition, libraries were afforded great flexibility and control not possible with their former manual methods. For example: collection inventory statistics of various types can now be obtained to enable the libraries to make more cost-effective decisions and provide better services to their users. Holdings can be monitored to determine what areas are being most utilized to assist in further developing the collections more effectively. Inevitable changes in cataloging practices, such as the current move to conform to AACR2, no longer present major labor-intensive problems. Deletions and additions to the collections are handled centrally, maintaining consistency and accuracy in the database.

---

*Henrico County Public Schools - Library Services

PROCESS

The Computer Company, a local vendor, was selected for the conversion process. This process of "going back to convert" is called retrospective conversion and results in a tape of data in MARC format (Library of Congress MARC-II Communications Record) which is an international standard.

Each library was responsible for entering data pertinent to its own shelflist. The Computer Company provided training for all library personnel working on the project, supported by clerical assistance and direction from the Henrico County Schools' Department of Library Services. A "hot-line" was maintained to keep in touch with customers for questions, problems and general interaction.

Each library's cataloging/input staff "searched" The Computer Company's database by entering into the terminal any or all of the following criteria:

The Computer Company's Bib-ID Number (Unique Items Number)
LC Card Number
ISBN
ISSN
Title Key
Author/Title Key
Author/Title Publication Date Key
Title Key/Publication Date

All main, subject, and added entries (including series added entries) for both authors and titles contained in the MARC record could be used as search criteria on The Computer Company's system, i.e., author, personal name, entry MARC fields 100, 400, 600, 700, 800 and title entry MARC fields 130, 245, 630, 730, 740, 830, 840.

The search criteria entered was captured and stored in the order in which entered, i.e., shelflist order.

When data was "matched" with the school record, the item was claimed and stored in the database for Henrico County Schools. The process of creating a database by matching records took approximately three years. At the end of the third year, the data was loaded into The Pueblo Library System, a program previously purchased by the public library system. This system, now known as LIONS (Library Information Online System), is an integrated system which uses a single database for acquisitions, circulation, on-line cataloging and patron access. The mainframe is a Unisys System 80 Model 9, which will be upgraded to Model 20 in the near future. The terminals are Unisys SVT1120. Some are UTS20 and Unisys PC (attachment).

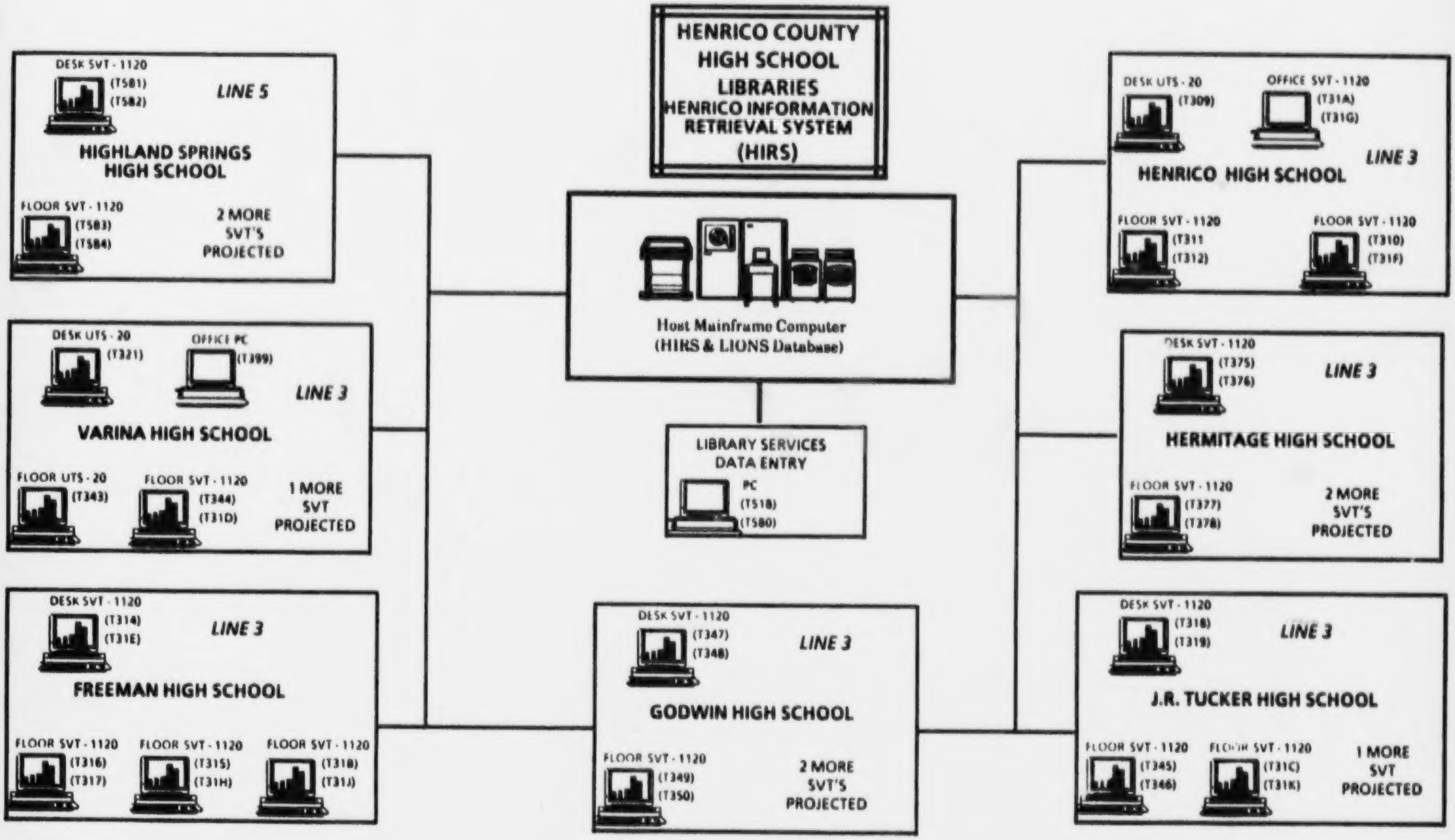
PRODUCT

After the data was loaded into the mainframe holding the database of the public libraries' volumes, access was created to holdings in excess of 250,000 titles, an expansion of 200,000 titles. Since retrospective conversion was done with The Computer Company which holds the Virginia State database, CAVALIR (Catalog of Virginia Library Resources), access to the materials of public and college libraries throughout the state is possible.

Each high school has specialized collection development so that expensive reference materials need not be duplicated but are available to each student or teacher through the on-line capabilities of the computer terminals. Data for materials such as videotapes, sound filmstrips, etc., available from the Division Media Center, has been entered into the database. An interlibrary loan system facilitates sharing these resources. In addition to this expanded collection of materials, each senior high school library has automated circulation capacities as well as the ability to inventory and maintain reserve and overdue records. These records concerning circulation, overdue notices and other reports facilitate management of resources. Another bonus of this system is that the public library card will give the student borrowing privileges at either the school or the Henrico County Public Library. School library cards are issued to students who do not have public library cards.

Instruction in the use of this database is an integral part of the comprehensive library skills program and serves as the basis for teaching search strategies, indexing skills, and for instruction in using commercial databases. The system makes possible the teaching of high-level thinking skills for accessing and evaluating information through the online public access catalog. Students are intrigued by the system and put to use indexing skills previously learned in a different context.

The use of computers for library operation has achieved the dual purpose of providing organized and systematic management of resources as well as serving as a tool to teach information retrieval skills in an atmosphere of relevancy for today and applications for the future.


HENRICO COUNTY
HIGH SCHOOL
LIBRARIES
HENRICO INFORMATION
RETRIEVAL SYSTEM
(HIRS)
Host Mainframe Computer
(HIRS & LIONS Database)
LIBRARY SERVICES
DATA ENTRY
PC
(T518)
(T580)
DESK SVT - 1120
(T581)
(T582)
LINE 5
HIGHLAND SPRINGS
HIGH SCHOOL
FLOOR SVT - 1120
(T583)
(T584)
2 MORE
SVT'S
PROJECTED
DESK UTS - 20
(T321)
OFFICE PC
(T399)
LINE 3
VARINA HIGH SCHOOL
FLOOR UTS - 20
(T343)
FLOOR SVT - 1120
(T344)
(T31D)
1 MORE
SVT
PROJECTED
DESK SVT - 1120
(T314)
(T31E)
LINE 3
FREEMAN HIGH SCHOOL
FLOOR SVT - 1120
(T316)
(T317)
FLOOR SVT - 1120
(T315)
(T31H)
FLOOR SVT - 1120
(T31B)
(T31J)
DESK SVT - 1120
(T347)
(T348)
LINE 3
GODWIN HIGH SCHOOL
FLOOR SVT - 1120
(T349)
(T350)
2 MORE
SVT'S
PROJECTED
DESK UTS - 20
(T309)
OFFICE SVT - 1120
(T31A)
(T31G)
LINE 3
HENRICO HIGH SCHOOL
FLOOR SVT - 1120
(T311
(T312)
FLOOR SVT - 1120
(T310)
(T31F)
DESK SVT - 1120
(T375)
(T376)
LINE 3
HERMITAGE HIGH SCHOOL
FLOOR SVT - 1120
(T377)
(T378)
2 MORE
SVT'S
PROJECTED
DESK SVT - 1120
(T318)
(T319)
LINE 3
J.R. TUCKER HIGH SCHOOL
FLOOR SVT - 1120
(T345)
(T346)
FLOOR SVT - 1120
(T31C)
(T31K)
1 MORE
SVT
PROJECTED

12/87

P.S. 2000: AN ACTION PLAN TO EDUCATE STUDENTS FOR THE 21ST CENTURY

MARILYN GARDNER, PH.D.

Abstract

P.S. 2000 outlines visionary change: in the breadth of student participation in methods and quality of teaching, in the preparation and motivation of children, in the contend and delivery of courses and in standards of achievement. P.S. 2000 will make significant and lasting change in education because it will lead to a basic change in the school culture. A new school culture will emerge that encourages teachers to embrace technology in order to improve their instruction and productivity.

Introduction

The Boston Schools are ready to transform the American education system by being the first in the United States to provide its children with the intellectual tools needed for the 21st century. Boston Schools proposes to be the first educational system in the world to fully tap the new information technologies that have revolutionized American industry and business.

The fourteen major projects outlined in the plan represent a powerful array of technological stategies, that when creatively applied and appropriately integrated, will help Boston schools reach three fundamental goals: improve the quality of learning, increase equity of educational opportunity and access, and ensure greater cost effectiveness.

The next five to ten years will be a transition period in which Boston education is transformed from the traditional delivery of learning based on time-in grade, to a system in which each student learns in a way and at the pace best suited to him or her.

Professional Development

The Professional Development model will provide a mechanism for change, that encourages teachers to embrace technology in order to improve instruction and productivity.

Goals

P.S. 2000 will be established in all elementary, middle, and high schools in the Boston Public Schools. There are four Phases (Phases I-IV), with the following goals.

Phase I

* Improving student academic performance.
* Developing more flexibility in delivering instruction.
* Creating a school culture where technology is sought as a teaching tool.
* Supplementing student access to educational opportunities after school hours.

Phase II

* Developing systems that monitor student performance.
* Providing access to information on individualized learning.
* Streamlining testing time and diagnostic instruction.

Phase III

- Implementing and upgrading technological applications in all academic, cultural arts and vocational curriculum areas.
- Increasing and improving breadtj and scope of educational opportunity.
- Maximizing and improving the quantity and quality of teacher training.
- Supporting new patterns of communication.

Phase IV

- Developing school-business-university-community and cultural institutional partnerships.
- Harnessing the technical expertise and resources of technology to meet community needs.
- The common threads woven throughout Phases I-IV include: technology becoming an integral tool in the teaching and learning process, extensive staff development, establishment of external partnerships, development of an evaluation design, and dissemination of information.

PHASE I-IV PROJECTS

A. Phase I Projects

Project 1: "Step Forward"
Need: To increase student achievement and improve remediation efforts in math, language arts and science.
Description: Computers and technological instructional tools in every classroom.

Project 2: The Homework Hotline
Need: Access to educational enrichment and remediation after school hours.
Description: Centrally located technology centers and telecommunications access from a child's home.

Project 3: ARRIVE (Adolescent Reading Revival)
Need: Develop an educational program that increases adolescent and adult reading and writing skills.
Description: One interactive instruction program laboratory in each high school.

Project 4: Beginners Plus
Need: Establish an early childhood computer-based instructional system that helps teachers build on each child's natural language growth.
Description: One laboratory in each elementary school for kindergarten and first grade students.

B. Phase II Projects

Project 1: Computer Adaptive Testing (CAT)
Need: Reduce testing time by at least two-thirds, increase test performance and improve test reliability and security.
Description: Test and item bank questions accessible at every teacher and student workstation.

Project 2: Information Management System for Teachers (IMS)
Need: Develop an information management system that effectively monitors student performance for teachers.
Description: Workstations in classrooms, teachers' rooms and remote workstations in teachers' homes.

Project 3: Information Management Systems for Administrators
Need: Develop an information management system that secures access to pertinent information for personnel in the administrative offices.
Description: Workstations on all administrators desks.

C. Phase III Projects

Project 1: Teleteaching
Need: There are increasing demands for higher academic standards for students and yet the declining ability of districts to provide the necessary instruction to all the schools within a district.
Description: One Teleteaching/Teletraining classroom in each school with two way video and audio capabilities.

Project 2: Upgrade
Need: To replace and upgrade traditional teaching and instructional methods, materials and tools.
Description: Upgrade the instructional tools of all academic and vocational programs.

Project 3: Teletraining
Need: To maximize the critically short amount of time available for teacher training and professional development through the use of technology.
Description: One Teletraining/Teleteaching classroom in each building with two way video and audio capabilies.

Project 4: Telecommunications/E-Mail Linkages
Need: To increase communications between teachers and administrators within and among buildings in order to share and respond to curriculum ideas and needs.
Description: Telecommunications capabilities in each teacher's classroom and home.

D. Phase IV Projects

Project 1: Home-school Linkages
Need: Increase student performance by the influence of new kinds of home-school linkages.
Description: A citywide lending library of computers and software for parents and a communications vehicle for teachers, administrators and educational materials via telecommunications.

Project 2: Community Linkages
Need: To harness the technical expertise and resources to meet the needs of community-based organizations.
Description: Collaborative computing centers in key locations in the community.

Budget

P.S. 2000 will be funded by the generous financing of the school department, the city, the state, the federal government and private business.

Phase I Budget

Category	Amount
Equipment	$8,562,500
Technical Support	1,345,000
Training	2,325,000
Curriculum Support	3,080,000
Services	800,000
Miscellaneous	522,500
TOTAL	$16,635,000

Phases I-IV Budget

		MILLIONS OF DOLLARS * * * * COST * * * *		
Phase	Stage	Onetime	Annual	Total
I	1	4.5	1.0	5.5
	2	4.5	1.0	5.5
	3	4.2	1.0	5.2
II	1	8.9	2.5	11.4
	2	8.9	2.5	11.4
III	1	8.9	2.5	11.4
	2	8.9	2.5	11.4
IV	1	8.9	2.5	11.4
	2	8.9	2.5	11.4
TOTAL		$66.6	$18.0	$84.6

Model Technology Programs
Lessons To Be Learned From Existing Models in California

Mrs. Bobby Goodson*

ABSTRACT

After attempting, for many years, to identify the proper role for technology, particularily micro computers, in education, there are currently a variety of "model" programs under way that may provide some very specific directions. It is important that these models be observed closely and their results considered seriously. Each model described here is designed to focus on a different aspect of the question. Taken together these models can provide a much clearer look at a possible new format for education.

For the past ten years, since the introduction of micro computers to schools and classrooms around the world, we have been learning by trial and error, by exploration and discussion the effects of technology on learning. We have an immediate need for more specific and detailed studies and for practical models from which to learn.

We have, over the past few years, imposed technology upon the existing educational system, endeavoring to select or create applications of technology that fit into the existing curricula and classrooms. Through the involvement of thousands of teachers in traditional classrooms all across the country we have learned that there is a place for technology, it does have a positive effect on the attitudes of students toward the learning process and it does enhance many of the areas of the traditional curriculum. Most of these experiments have had little or no continuity from year to year or from one subject area to another. It is important that we move ahead and take the best of the classroom models and teaching techniques that we have seen and incorporate them into broader models. It is equally important that we make a real effort to learn from these models and apply the successful strategies as broadly as is appropriate.

There are now a variety of model programs in California, two funded by the State and a third group established by industry, from which we hope to gather greater understanding and move ahead toward new learning environments built on a

* Education Technology Consultant, Sunnyvale, CA
Past President, ICCE

stronger foundation. Fortunately, each of these models are focusing on different aspects of the educational equation. The state funded Model Technology Schools Project is designed as a multi-year study of a school system, from kindergarten through twelfth grade. By observing the effect of a high level of infused technology throughout the educational process, we hope to begin to gather some longitudinal data on the effect of technology on individual learners, on teachers and upon schools. There are five of these models, in urban and suburban communities and in large and medium sized districts.

During this first year each of these projects is focusing their attention on the elementary school. An analysis of the learning environment, the acquisition of hardware and the ongoing training of teachers was the first order of business as schools opened. Throughout the year multiple technologies are being incorporated into all levels of these schools. Three of these projects have centered their programs on the individual students, their ability to use the tools now available to them, their thinking and communication skills throughout the standard curriculum and their ability to become self-motivated learners. The fourth project is addressing the needs of students and teachers and the implementation of the Language Arts curriculum in a technologically rich environment. Since this is an inner-city school district there will be special attention paid to particular groups of students (those with English as their second language, those from low socioeconomic backgrounds, etc.). The fifth project is emphasizing the teacher use of the technologies, providing teachers with ready access to equipment and resource materials, on-going training and a support network with the expectation that this will have a beneficial effect on the teaching strategies and techniques throughout the school.

During subsequent years each of these programs will be extended into the intermediate or middle schools and finally into the secondary schools. In this way it will be possible over the next several years to follow students through their educational development and observe the cumulative effect of successive years in these technologically rich environments. It is important to note that all five of these models have developed strong partnerships - research partnerships with nearby universities and implementation partnerships with business and industry.

The Model School Curriculum Project, also funded by the state, will study the effect of the integrated use of a variety of technologies in specific curriculum areas. The individual sites for this project cover all grade levels and several individual curriculum areas. There are two sites, one in elementary and the other in an intermediate school, introducing technological resources into language arts instruction. The intermediate site will make a special effort to work from a literature base and encourage the wide use of word processing and data bases. Similarily, the elementary school social science project will also be working with the language arts literature curriculum, endeavoring to link the two curriculum areas, enhanced with the infusion of technologies. The high school social studies project will be incorporating a variety of technologies and experimenting with interactive video as learning media.

Other model curriculum projects will be studying the use of the video disk in elementary math instruction and the use of a computer lab as an extension of the junior high school science program. The elementary science project will endeavor to improve science instruction throught the K-6 grades, making use of as many technologies as possible. They will be focusing on the development of critical thinking and problem solving skills through the science instruction. The final site in the Model School Curriculum Project will be endeavoring to improve the instruction in the Fine Arts throught the first eight grades. This project will use video technology to increase student access to performances and other visual arts and use computer and video technology to ensure equal access to means of creative expression by previous "non-artists.

There are a variety of projects funded by industry that provide us with the opportunity to observe with effects of a large infusion of computers into the learning environment. Each of these models focus on a different aspect of the total picture.

Apple Computer has funded a series of model sites around the country in which we can observe the effect of complete access to computers by all students on learning and the general educational environment. By providing each student with a computer in the classroom and at home, it is possible to observe the effect of computers on the educational process if access is removed as a variable. In California we have two such sites. The first is made up of double classroom for a third grade and a second/third grade class. Students are able to use a computer at any time and in any subject where it seems desirable or appropriate. They develop keyboarding skills very early in the year and truly use the computer as an aid to learning and expression. Another elementary school has been provided with a Macintosh laboratory and additional Macintoshs in the classrooms for the use of young students. This model gives us an opportunity to watch the effect of providing students with advanced tools at the beginning of their academic career and observe the effect on their creativity and understanding

Still another elementary school has been transformed with the help of IBM. Rather than studying the effect of technology directly on the students the teachers have been provided with computers at home and school, and with ongoing training and support. This is expected to encourage them to explore all of the possible ways they can utilize the technology in their classrooms and expand their horizons as teachers. It is hoped that this model will provide a real look at an evolving philosophy of teaching and the learning process. This study will pay particular attention to the effect of the women teachers as role models on computer use by the girls.

There is much to be learned from all of these models, each of them contributing another piece of the technology utilization puzzle. It is essential that we observe the progress of these and similar models over the next few years and take advantage of the best that each demonstrates. We have an opportunity to watch what happens to a student who learns to use technology and apply it to the learning process year after year. We will see how an infusion of technology can change the way subject matter is taught. We will see how large numbers of computers and associated technologies affect the way students learn and teachers teach. It remains to be seen if we can apply these lessons and adjust our perception of the educational process as a result.

THE EXPERIENCES OF A COMPUTERS IN TEACHING INITIATIVE PROJECT

Katherine J. Day*

ABSTRACT

One of the UGC/Computer Board funded Computers in Teaching Initiative projects had an independent summative evaluator in place from the outset. This paper discusses how and suggests why things turned out the way they did in the two 'demonstrator' sub-projects of Edinburgh's 'Development of Educational Software in University Teaching' project, June 1985-87. An opening review of the project's focus, resources and structure, is followed by consideration firstly of the conduct and pacing of activities and secondly of their associated outcomes and costs. The necessarily brief analysis concludes by indicating what implications the experiences of this particular project might have for future developments within the field of computer-based and computer-assisted teaching and learning.

INTRODUCTION

Among the many projects funded under the UGC/Computer Board CTI was one at the University of Edinburgh where the host institution employed a half-time independent evaluator to observe, reflect and report upon project experiences. Now that this summative evaluation has been fully completed I welcome the opportunity to share some of the 'findings' with a wider audience, though they do not of course have any 'official' status.

PROJECT FOCUS

The 'Development of Educational Software in University Teaching' project, which ran from June 1985 -87, was made up of two 'demonstrator' sub-projects in the departments of Meteorology (MET Project) and of Economic & Social History (ECSH Project). MET Project wanted to devise an interactive graphics tutoring system to help undergraduate students come to grips with the tephigram (a complicated graph with five sets of axes used to investigate the vertical structure of the atmosphere). ECSH Project wanted to enable students to engage in the exploration,analysis and representation of historical data. The existence of two sub-projects with differing objectives but operating within the same broad institutional framework provided a useful comparative perspective for the evaluative task of recording how and suggesting why things worked out the way they did. Whilst the project's main aim was "to produce actual software products", the institutional experience thereby acquired was always regarded as a crucial by-product with long-term implications.

PROJECT RESOURCES AND STRUCTURE

Financial resources amounted to £102,000, representing a 3:2 input ratio between the Computer Board and Edinburgh University, who were also committed to providing 'uncosted general support'. One fifth of the available funds was for four development machines but the bulk was for staff costs. Cross-disciplinary teams, with academic, computing, educational and managerial components, were assigned to the project(s).

The basic production group for each sub-project was made up of:
The equivalent of one full-time computing officer
    - 1 programmer for ECSH Project (3/4 time)
    - 2 programmers for MET Project (1/2 time+1/4 time)
    - 1 computing officer half-time shared between sub-projects (1/4 time +1/4 time)
One quarter of an educational researcher
    - 1 educational researcher half-time shared between sub-projects (1/4 time +1/4 time)
Two people without any project-specific funding or time allocation
    - an academic member of staff from the department concerned
    - a computing service manager

*Secretary's Office, University of Edinburgh, Old College, Edinburgh EH8 9YL

There were thus differences between team members in terms of whether they were specifically funded or allocated time to work on the project(s). For the academics, in particular, project involvement was an 'extra', to be accommodated in 'marginal' time. As the project proceeded the University also bought in some additional temporary help .

SUB-PROJECT PROFILES

The sub-projects were brought together quarterly in formal project meetings, but had separate identities and conducted their affairs largely independently. This meant that while they had some parallel experiences, the differences in their tasks, team composition, and related operational styles affected the way things went. MET Project sought to develop a micro-based instructional package as a more efficient and effective means of teaching and learning an existing topic, whereas ECSH Project was concerned to offer students hitherto unavailable opportunities for data exploration, rather than to transmit a body of knowledge. As regards team membership there was more of an 'overlap' between those working on MET Project compared to ECSH Project. This existed along a number of dimensions including subject knowledge, computer experience, prior acquaintance and physical location and made it that much easier for MET Project to operate as a close knit unit. There were corresponding differences in internal communication patterns and interaction levels, which tended to be more diffuse, formal and intermittent in ECSH Project.

PROJECT HISTORIES

Notwithstanding these sub-project differences, there were considerable similarities in the sequencing and pacing of activities, with three rough life-history phases discernible. Machine choice and design issues took up the first nine months, prototype software development the next nine, progress assessment and consolidation the remaining six.

The sub-projects were equally committed to a user-friendly development environment, though the detailed decision process differed because their particular task requirements determined the choices made. The considerable difficulties associated with identifying, accessing and testing out promising looking hardware and software were exacerbated by a rapidly changing and developing WIMP-based micro market. In consequence both sets of developers only had access to their chosen kit, (in MET Project the Torch Triple X using Unix and 'C'; in ECSH Project the Apple Macintosh using TML Pascal), about a third of the way through the project. The process of clarifying design issues was likewise project-specific because different types of CAL software were sought (MET Project an instructional system; ECSH Project an exploratory tool). Again similar problems arose. ECSH Project did not anticipate the need for a 'functional specification' and MET Project did not appreciate the amount of work entailed in providing a detailed 'educational specification'. Both sub-projects found themselves unable to engage in the kind of detailed software planning required without the assistance of University funded consultants.

During the software development phase MET Project made greater progress than ECSH Project for a variety of reasons. In ECSH Project, where 'client-contractor' type relationships between the 'academic' and the 'computing' sides were not always harmonious, managerial control was problematic. In MET Project the academic was clearly in the driving seat, working alongside the programming staff and using task scheduling to organise activities and register slippage. But both sub-projects proceeded more slowly than hoped, due partly to familiarisation with new programming environments and partly to the complexities of CAL. Dissemination, including report writing, also emerged as a further responsibility of project involvement, proving to be a mixture of stimulating and time consuming.

The 'stocktaking' phase was perhaps advanced somewhat by the internal reorganisation of the University computing service, but both sub-projects felt the need to draw things together. However while MET Project was able to trial and revise first version software, ECSH Project had to concentrate on trying to prototype software features not currently available. Aided by their summer student, MET Project succesfully completed three levels of the package including user facilities such as Help, Notepad and Worked Example. In software production terms ECSH Project emerged with far less to show for their efforts.

Throughout the two year period the project(s) were materially assisted by the activities of the educational researcher. Besides contributing generally to discussions, he conducted a series of investigations into teaching and learning processes, within both conventional and computer-assisted settings, whose findings could inform sub-project decision making.

PROJECT RESULTS AND COSTS

The difficulties involved in identifying in advance what tasks would need doing and in estimating their duration, generally led to the compression of time-scales, resource shortages, and time-management problems for team members. As a result some project targets were not met. But in addition to assessing achievements in terms of what the project(s) set out to do, it is important to identify what else the project(s) yielded.

Although MET Project was clearly more successful as regards software output, producing a package that 'as is' would take a student upwards of three hours to work through, and with the necessary investment could be extended to cover the rest of the teaching specification's eight levels, there are other aspects to consider. It proved imposible to construct a system that responds as flexibly and sensitively to individual students as a human tutor. The difficulty of providing student access to hardware means that the software is likely to be used for optional revision purposes rather than integrated into the curriculum, and it's efficacy is anyway as yet untested. Moreover it took a huge amount of effort to develop from the ground up materials for part of a single course in a subject taught at one other British University. As for ECSH Project the department patently did not get the tool for 'doing history' that it wanted. But there were other positive spin-offs from project involvement, which included the extension of WIMP-based micro experience and the consideration of computer usage in teaching within the department. It also helped their applications for other funding to buy more micro equipment, and to support the development of appropriate data sets. So the longer term impact appears more substantial.

In servicing the project the educationalist developed research instruments for observational analysis, that are now available to others working in the field. He also helped to increase project members' appreciation of the complexities, (related to teaching, learning, and assessment), necessarily entailed in the design, development and deployment of CAL.

The cross-disciplinary contact between project participants proved fruitful, if not always unfraught. Their knowledge and experience were considerably expanded as members acquired new areas of specific expertise, which now exist as an institutional resource. The 'costs' incurred by the project were both financial and personal, neither of which was without repercussions for the home institution. Almost all project participants felt however that, institutionally as well as individually, the benefits derived outweighed the 'costs'.

Costed project expenditure amounted to just under £120,000, with salaries around the £91,000 mark, equipment absorbing about £24,000, travel expenditure £1,500, and computer related consumbles £1,000. The additional 'uncosted support' provided (which included the time of unfunded participants, employee benefits and overheads for accommodation, maintenance and utilities) meant that the University's total contribution exceeded the original Computers in Teaching Initiative award of £62,000.

PROJECT EXPERIENCES AND IMPLICATIONS

It was always clear that since project personnel and activities were embedded in wider networks, project happenings could not be treated as self-contained. The differential impact of and response to the project within the relevant departments, for example,was related to their size and structure as well as to contrasts in how the sub-projects functioned and fared.

The overall organisation of the project had certain features which turned out in practice to have mixed effects.
- Relations between the sub-projects were reasonably cordial but not close. Although it provided some comfort when similar problems were encountered, the existence of two parallel sub-projects had a competitive edge as regards resourcing and progress. People who straddled both sub-projects had a double perspective but also double duties.
- The team approach supplied a range of perspectives and skills, but there were still functions, such as clerical support, documentation/information and project management, which were not well provided for. Once a project gets underway the outside world legitimately wants to know what is going on and the project itself gains considerably from contact with other interested parties. The absence of well-defined areas of managerial responsibility was unfortunate and needs to be given explicit attention, tailored to the individuals actually involved, because a funding proposal in not necessarily a blueprint for action. In fact the general lack of detailed role-articulation created both flexibilities and ambiguities for occupants that could not always be turned to the project's advantage.
- The physical aspects of the project were not explicitly considered, so that whilst core members of MET Project were readily in daily contact, this did not happen in the other sub-project where the academic and programmer were not co-located.
- In the absence of explicit pre-arrangements the academic contribution had largely to be made in marginal time. In view of the amount and the consistency of effort required this would not appear appropriate, though even partial 'secondment' is not necessarily the solution to this problem.
- The difficulty of allocating time equitably and effectively, which everyone experienced, plus the coordination of activities was increased for anyone assigned less than half-time to the project(s). Yet two part-timers rather than a 'lone operator' may prove beneficial, especially for the programming effort when working with new systems.

Project experiences confirmed much of what is already known about CAL. For example,
- that development is a high-cost, high-risk and demanding enterprise, especially in the case of 'ground-up' educational software, drawing on various skills and expertise and requiring the commitment of considerable time and effort.
- that the competitive pressures entailed in securing financial support reinforce the sometimes mistaken impression purveyed by single-shot (as opposed to 'turn-key') funding policies that everything is ready to roll providing 'seeding' or 'pump priming' funds are forthcoming.
- that the more informed project participants are at the outset about all aspects of CAL (from computing, educational, and subject domain perspectives) the better.
- that the development of CAL packages is suffused with educational implications which cannot be satisfied simply by periodically injecting a dose of 'educational principles'.
- that the deployment of CAL imposes significant overheads in terms of delivery costs (including the provision of teaching laboratories which have to be equipped, staffed and kept well-stocked).

Project experiences suggest the importance of
- developing pools of expertise about the varieties, possibilities and pitfalls of this kind of teaching and learning, about the suitability of different environments and applications, and about how best to tailor packages to suit requirements in specific contexts.
- assessing the effectiveness of software packages in regular usage, including their associated teaching strategies and learning opportunities and the way they are/can be integrated into the curriculum.
- trying to establish at national, and indeed international levels, what types of computer mediated teaching and learning activities are worth pursuing within different kinds of educational environments, especially given the competing claims on resources.

UNIX/XENIX AND LANS - THE SOLUTION?!

M. GENE BAILEY

ABSTRACT

Many universities and colleges are investing in Local Area Networks in their frustrated attempts to stay abreast of the state-of-the-art computer technology. Others are considering multiuser systems on a scale much smaller than the large mainframes to which they have been accustomed to buying or leasing. One of the more popular mini- mainframe- multiuser systems, UNIX, has been ported down to the microcomputers. Universities are scrutinizing very carefully the available micro versions of UNIX - due mainly to their efforts to seek cost-effective means to maintain a hold on advancing technology.

The IBM-compatible version, XENIX, developed by Microsoft and currently being modified by other software vendors is stirring controversy as the experts argue its benefits. The IBM-dominated world of PC DOS is reluctant to consider its fledgling competitor and is promoting the use of networks primarily on the basis of the independence they provide the user. An ideal solution may be to consider a DOS/UNIX operating system which would offer the best of each.

This paper discusses the pros and cons of LANs and of multiuser systems, particularly UNIX/XENIX. It also discusses the roles that universities and colleges must play in their efforts to educate their students in and with the latest technology.

INTRODUCTION

Higher education, with a few exceptions, has historically lagged behind industry in implementing state-of-the-art computer technology. Primarily because of a lack of funds, colleges and universities are often using outdated mainframes for teaching purposes while the "real world" surges ahead with increasingly smaller and more sophisticated systems. In attempts to stay abreast of current technology, many universities have opted for either microcomputer labs or for a requirement that their students purchase a particular microcomputer.

There are problems with both of these methods. Those schools using microlabs are required to purchase a licensed copy of the software for each machine on which it will be used. At the very least, a site license is required, but these are available from only a few of the major software developers. Some vendors offer "student" versions which are, in effect, restricted modifications and do not provide experience with the actual package.

The second method, that of requiring students to purchase their own microcomputer, places the burden of the expense on the student. Though available by discount, the combined cost of software and hardware adds a significant amount to the cost of their education. Students who may already own a system often find their compu do not meet the university requirements.

M. Gene Bailey, PhD, East Tennessee State University, Johnson City, TN, USA

THE SOLUTION - LANS/UNIX ?

To reduce the cost of providing the hardware and software, higher education should consider alternatives such as Local Area Networks (LANs) and multiuser systems such as UNIX and XENIX. In 1985, the hardware alone for an office computer system for 10 to 12 users cost as much as $50,000. Today, the same kind of system is available for under $10,000 (ref 1). The main thrust of LANs is to allow users to share peripherals, particularly expensive ones such as laser printers and large-capacity disk drives, that they might otherwise not have been able to afford. They are an outgrowth of the standalone PC market and primarily feature the DOS operating system. They allow users to continue running the same popular wordprocessing and spreadsheet programs that they did as standalones.

The advantages to a LAN include sharing resources, increased faculty productivity, ease of use, and integrity. According to Dr. Alan Leviton at the California Academy of Sciences, "...the network doesn't inherently enable us to do anything we couldn't do as individuals on standalones, but it allows us to share resources with others...We have an advantage over them [mainframes] because we have on-line access and we don't have single-point failure...if the file-server goes down [for any reason]..it doesn't mean the individual is necessarily locked up."(ref 2) Dr. Alton Brantley, director of Academic Computing at Duke University comments, "One of the advantages of a networked system is that even though you've got 20 or 30 machines attached to it, logically there is still only one system that requires maintenance."

On the other hand, UNIX-based systems are more difficult for the non-technical user. Terry Keene, President of Technology Research Group in Atlanta admits "UNIX is scary and untenable for the average DOS user...a house of cards. As long as every card is in place, it works fine. If you pull out one card, the system crumbles. YOu need to know a lot about cards to put it back together."(ref 3) However, UNIX, as a multiuser operating system, offers superior file and resource management, as well as a high degree of probability when compared with other operating systems.

RESPONSIBILITY TO THE STATE-OF-THE-ART

At issue too, is not only cost effectiveness but the responsibility of higher education to properly prepare its graduates for employment. The growth of LANs, and now multiuser micro systems is phenomenal. A report from Business Communications Company estimates that 27% of all establishments employing 20 or more people in the United States have a local area network. They project an annual growth rate of 9.1% in factory and office LANs to 1994(ref 4). Surveys conducted by PC Week in 1986 and 1987 indicate the percentage of corporate and institutional sites with installed LANs more than doubled - 29% to 59% - between August 1986 and September 1987. Further data from the surveys indicate that 73% of all sites using microcomputers will have LANs implemented by the end of 1988 (ref 5). Raymond Noorda, President of Novell, reported in his keynote address at Networld 86 that an analyst's projection the industry could be a $9 billion one by 1990 might even be "a little low."

According to Lee Caldwell, assistant dean of computer science at the University of Utah, computer networks are not being sufficiently used by academia. "Higher education needs to rethink their use of microcomputers. Networks are used quite effectively in administrative work. But more of them need to be devoted to student use." He estimates that even for academically-oriented universities fewer than 50% of campus LANs are available to students.

Students in computer science courses should be studying networks and multiuser micro systems. They are, however, studying operating system, compiler, and language courses that are limited, typically, to mainframes. The same colleges and universities who have implemented AT&T's UNIX on their minis and mainframes are reluctant to consider micro versions.

SECONDARY EDUCATION AHEAD OF HIGHER EDUCATION

Higher education is not only lagging behind industry, but it is trailing secondary education in using networks and multiuser systems to further learning skills. This past fall, schools in Utah, Nevada, Colorado and Kansas used personal computer networks to teach Spanish. Other schools across the country have installed networks under a vendor-logo agreement between IBM and Novell. Students study a variety of subjects, including a new series of educational programs developed for IBM by WICAT, Inc. of Orem, Utah. Formal skill comparisons are not yet available, but response from students and teachers has been extremely positive. The LAN provides users with a number of features, but the ability to share software without floppy disks has been particularly convenient. An AT file server storing 90 megabytes of coursework is managing the equivalent of 3,000 diskettes (ref 6).

Several college faculty are leaders in micro multiuser systems as evidenced by work done at the University of Nottingham in England. Faculty, there, wanted a low-cost workstation that would offload users from a UNIX timesharing system. The machine would handle applications such as document processing, provide a friendly user interface, and emulate standard terminals as necessary. The machine they chose - the Apple Macintosh. They use a special interface board which lets the Macintosh serve as a graphics front end to UNIX machines (ref 7).

COMBINE DOS/XENIX

Networks and multiuser systems are essential components as tools for use and as areas of study in colleges and universities. Each offers features that complement the other. Rather than choose which system to use, perhaps an ideal solution would be to implement a PC DOS/UNIX network. This would mean the ability to interconnect PCs and compatibles running MS-DOS to micros, minis, mainframes, and super-computers running UNIX. The small PC would serve as the workstation; the UNIX system would be the administrator. The DOS system has the software- the UNIX system has the multiuser, multitasking capabilities that enable it to provide file, print communication, and computation to many personal computer users.

The ultimate goal of both multiuser and networking is the realtime sharing of resources and information by a number of users on a single computing system. Standalone systems, given equal technology, will always offer faster response times to demanding users than shared-logic systems. In addition, a greater selection of applications software is available for DOS users along with a variety of advanced user-interfaces such as bit-mapped graphics and windows. However, for DOS and other single-user environments on-line information and resource sharing is available only through LANs. This means not only an initial investment in LAN hardware, but also an additional PC and LAN connection for each new user on the network. Often, multiuser MS-DOS software is required to handle access to data files to avoid problems caused by unsynchronized access.

With UNIX systems, on the other hand, multiuser, multitasking operation with record- and file-locking data security is provided with the system. In addition, only one CPU is required for as many as 16 (or even more) users, each of whom requires only an inexpensive terminal. File management and system administration facilities are on par with those of powerful mainframes. Many universities have been using AT&T's UNIX on the PDP minis and mainframes for several years. The new 808386 machines offer them mainframe-like capacities with the micro-ported XENIX system at a fraction of the cost.

Conclusion

Doug Michels, vice-president of The Santa Cruz Operation advocates that in most environments there are good reasons for having both single-user and multiuser machines. "The obvious solution is to support both machine types on a single LAN and in an individual administrative unit."(ref 8) All XENIX systems connected to the network can act as file, print, and processor servers for other MS-DOS and XENIX systems. MS-DOS users see XENIX resources just as they would see remote disk drives or printers connected under DOS-based networks.

Clusters of XENIX and MS-DOS machines on the network would be administered as a single UNIX system, preserving the user-and-file- system security schemes of XENIX across the network and extending them to MS-DOS users. Many languages are available for both operating systems, making it easy to cross-develop between environments. This is important in higher education whose responsibility it is to prepare students for the multiuser, single-user, and networking systems they will encounter in industry. The DOS/UNIX (XENIX) system gives users the best of both XENIX and DOS, without sacrificing the functionality of either.

Colleges and Universities will be able to retain their DOS machines and supplement them with UNIX-based PCs as they need to add users, power or functionality. New operating environments are already available that let businesses run DOS and UNIX on one PC-based multiuser system. The new (and affordable) 386-based systems will let users run both UNIX and DOS or OS/2 on the same machines. Industry is surging ahead. To keep up higher education must consider networks and multiuser network systems as not only cost-effective alternatives to mainframes, but as alternatives that are actually closer to state-of-the-art or at least, state-of-the-industry.

REFERENCES

1. T Keene, Atlanta Bus Chronicle,Sept 14 1987
2. M Judson, LAN Times, Nov 1987, p 14
3. J Beaver, Comp Reseller, July 1987, p 42
4. Report from Business Comm Co, 1986,Norwalk Conn
5. R Stromer, PC Week, Nov 24, 1987, p 176
6. C Snapp, LAN Times, Aug/Sept 1987, p.48
7. H T Smith,W J Armitage, R J Duckworth, BYTE, July 1987, p 159
8. D Michels, UNIX World, Oct 1987, p 144

LOGIC PROGRAMMING AND OPTICAL DISK TECHNOLOGIES IN THE KELLOGG PROJECT

Ernest Sibert and Anne Shelly*

ABSTRACT

The Syracuse University Kellogg Project is funded by a four-year, $3.7 million grant from the W.K. Kellogg Foundation. Its purpose is to make accessible internationally the University's Adult and Continuing Education Archival Collection using the combined technologies of optical-disk storage, logic-programming knowledge-base access, and advanced networks for world-wide document and information dissemination.

INTRODUCTION

Over the past 38 years, the Department of Adult Education at Syracuse University has collected a wide variety of print, visual, and media resources related to the education of adults. A large portion of this collection is archival in nature, with the past records of adult education organizations, associations, and leaders available to historical and bibliographic scholars. Thus, the Syracuse University Libraries now house the most comprehensive assortment of English-language adult education resources in the world. The printed materials alone total perhaps 1500 linear feet (an estimated 5-6 million pages), which includes correspondence, financial records, published materials, personal papers, photographs, and miscellaneous materials. Items may be holograph, typed, printed, carbons, or photocopies. Some pieces will combine two or more of the elements just mentioned. The collection acquires additional materials each year.

Unfortunately, the Adult and Continuing Education (ACE) Collection has not yet been used to maximum advantage. Despite Syracuse University's commitment to adult education, storage and processing limitations have precluded both full use of the materials for research and dissemination of the materials beyond the Syracuse campus. In 1986, the Kellogg Foundation of Battle Creek, Michigan, joined with Syracuse University in an effort to open this major resource to scholars and practitioners at the University, in the region, and around the world.

The Kellogg Project has three major components, each designed to tap the enormous potential of the ACE Collection. They are as follows:

- Dissemination based on optical-digital storage and computing technologies, concomitant professional research to make optimal use of the Collection materials, and continuing development of the Collection.
- Creation of an electronic network and software for interactive access to the collection and associated information.
- Pursuit of educational opportunities such as research, independent study, and conferences.

SCOPE OF THE EFFORT

Even with recent advances in write-once-read-many optical storage, it will not soon be feasible to keep the entire collection on optical disks. The present effort will, however, involve installation of a computer system* with the capacity for some 750,000 pages, stored as compressed, monochrome raster images; we anticipate digitizing the initial images at 300 dots/inch. The system includes a file server (Plexus P95 processor with both optical and magnetic disks) and several workstations with high-resolution displays, which provide stations for: 1) scanning documents, 2) indexing and filing images, 3) interactively examining stored images, and 4) printing images. The workstations are connected to the server through a local area network (10 Mhz. Ethernet). The entire system will be connected to a high-speed token-ring network providing access to all major computing facilities on the Syracuse campus, with a gateway to the New York State Education and Research Network (NYSERNET), and thence to all major interactive networks. This provides a path to non-interactive networks (e.g., BITNET) as well.

---

*School of Computer and Information Science and Center for Computer Applications and Software Engineering (CASE), Syracuse University, Syracuse, NY 13244.

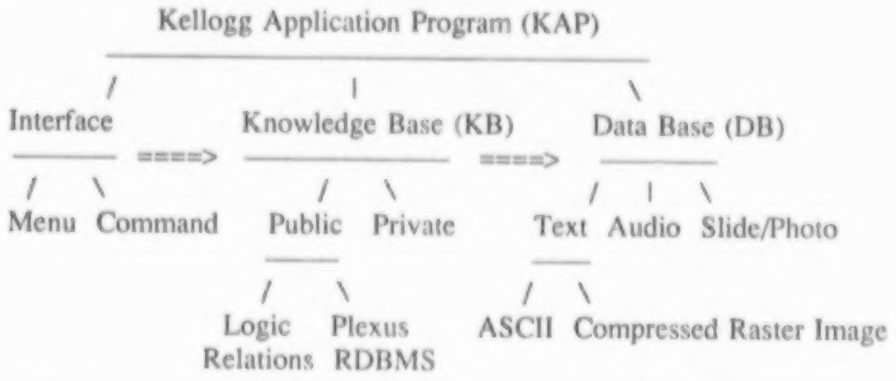
At the moment, a pilot system is in place including server, modest file space, scanner, printer, and four workstations. We are experimenting to determine suitable scanning techniques, since much of the material is of low contrast and difficult to digitize, and are refining specifications for future software.

Eventually the system will provide for digitization and display of color images (from 35mm. slides) as well as digitization and playback of audio materials, though the storage capacity now planned will permit only limited amounts of such materials.

Although digitized images are the primary, archival representation of documents in the collection, we can also store conventional character (ASCII) files representing documents. These add less than 10% to storage requirements, and permit direct processing of the text of the document, full-text indexing (if desired), and efficient transmission over low-speed communication lines, hence access from ordinary terminals. Presently such files are prepared off-line using a Kurzweil model 4000 trainable OCR system, then uploaded to the server, or any convenient host computer. The system may, at a later date, include OCR equipment that processes the stored images directly.

ACCESS USING A LOGIC KNOWLEDGE BASE

While users will have conventional information-retrieval (i.e., bibliographic) access to the stored images through the Plexus' relational database management system (RDBMS), they will also have access through a logic knowledge-base system employing mechanized deduction techniques (refs 3-6). At the present time, we envision the logic system in the following configuration:



---

*XDP mixed-mode data processing system, product of Plexus Computers, Inc.

The knowledge base (KB) is designed to capture information about use of the Collection, i.e., how users organize what they know to characterize their information needs, to identify stored material, and subsequently, to gather new information. We organize and store users' knowledge, i.e., their interpretations of materials in the Collection; this information ranges from archivists' formal cataloguing schemes to individual researcher's interpretations. These descriptions are stored as *relations*. The computing environment provides great flexibility in writing relations with any number of variable-length fields or arguments and in combining relations or parts of relations to form new descriptions from existing information.

Currently, KB relations are developed from three sources:

1. All shelf list descriptions in the *Syracuse University Manuscript Holdings* Bluebook (ref 1), an archival catalog of currently processed materials in the Collection;
2. A limited number of experimental relations describing one set of unprocessed materials, those of Adult Education scholar, Howard McClusky. These relations are, in part, developed from analyses of data collected by project researchers who are interviewing individuals within the Kellogg Project, with experience using the ACE Collection, and/or with an interest in Adult Education research. From these analyses, we are identifying the language and constructs of potential Collection researchers and are incorporating them as descriptors (i.e., KB relations) of the stored materials;
3. System records of users' interactive sessions, i.e., how researchers manipulate the knowledge base and how they interpret the portions of the Collection identified by their interactions with the knowledge base. With a user's permission, the system records these interactive sessions including new relations and queries.

Two interfaces to the knowledge base will allow users to explore the descriptive information as a method for identifying the portions of the Collection relevant to their interests.

1. One is a highly structured, menu-driven program that guides the user through a series of choices of existing knowledge-base information. During the past year, conversations with vendors, staff, advisory council members, and interested members of the University community provided convincing evidence that potential users perceive the need for a highly structured, easy-to-use entry-level interface. The interface format of choice was overwhelmingly menu-driven.
2. The second is a less structured, command-driven program that allows the user to manipulate the information within the knowledge base directly. This program allows the user to build and to manipulate combinations of relations in the public KB and his/her private KB through the use of logic variables and of pre-defined rules and queries. To date, we have approximately fifteen rules and a wide variety of commands that allow the user to perform full-text searches of the existing KB and DB. In addition, we have implemented rules that account for the variety of date forms contained in the Bluebook shelf-list descriptions.
3. We wish to note the use of a third interface which builds on the second program by allowing the user to define his/her own relations and to establish conditions for queries unique to his/her interests. At this level, the user has access to the command-driven interface; at the same time, the underlying logic and LISP programs are entirely transparent to the user. This interface is the working vehicle

from which the command-driven program will evolve; it is also the environment in which the public KB and ASCII DB documents are generated. We intend to offer it as a working environment for users with expertise in computing and/or a high need for great flexibility in using the system.

GOALS AND ISSUES

The major goals of the Kellogg Project include expanding the use of resources available to adult educators and "promot[ing] information exchange among adult educators" (ref 2). The use of advanced technologies to achieve this goal continues to raise numerous logistical and conceptual issues for us. Logistical issues include those related to copyright, optical character recognition (especially conversion from image to character codes), access related to technological capabilities of potential users, and digitization of sound and color materials in the Collection. Conceptually, we are exploring theories of knowledge representation and of teaching/learning strategies which seem most promising as the basis underlying our implementation of knowledge-base relations i.e., representing the cumulative knowledge of system users, and of the user interfaces, i.e., providing a balance of structure and flexibility that fosters effective system use.

REFERENCES

1. Charters, A. (Ed.). *Adult and continuing education collections in the Syracuse University libraries.* Syracuse, NY: Syracuse University (1977).

2. Dosa, M. *The Kellogg Project's international information sharing network,* Background paper. Syracuse, NY: Syracuse University, School of Information Studies (1987).

3. Robinson, J.A. A machine-oriented logic based on the resolution principle. *J Assoc Comp Mach,* **12**, 23-41 (1965).

4. Robinson, J.A., & Sibert, E.E. LOGLISP: Motivation, design and implementation. In K.L. Clark & S.-A. Tarnlund (Eds.), *Logic programming.* (pp. 299-313). New York: Academic Press (1982).

5. Robinson, J.A., & Sibert, E.E. *The LOGLISP programming system.* LPRC Technical Report. Syracuse, NY: Syracuse University, Logic Programming Research Center (1984).

6. Sibert, E.E. & Shelly, A.L. *Logic programming: Computer programming that complements qualitative research.* Paper presented at the meeting of the American Educational Research Association, Chicago (1985, April).

A CAL PACKAGE TO LINK SEMICONDUCTOR PROCESS ENGINEERING AND ECAD

Paul R C Stevens and James M Noras

ABSTRACT

We are compiling a set of programs to link the study of semiconductor process fabrication to the parameters of resultant devices. This offers a much broader approach to teaching electronic systems design, which normally starts with specified device parameters or design rules. Students can investigate the effects at circuit level of choices made at fundamental process levels, and are able to understand much more readily the basic physical and electronic processes and their vital role in determining the behaviour of devices, integrated circuits and electronic systems.

INTRODUCTION

In 1985, as the result of a joint initiative between the University Grants Committee and the Department of Education and Science, UK universities and polytechnics were equipped to educate students in the use of CAD tools which are currently employed in industry for the design, simulation and testing of electrical and electronic circuits. In particular these tools are applied to the design of integrated circuits which can be fabricated by commercial silicon foundries. Where electronic and electrical engineering courses have been changed to incorporate ECAD experience, it is the concept of using ECAD as a route to VLSI design and manufacture that has received most emphasis. Teaching material presented to students can be summarised roughly as:

a) Instruction in specific ECAD packages, e.g. using Silvar Lisco software for schematic capture or HILO for digital simulation;

b) Experience of design, simulation and fabrication of VLSI circuits, usually through project work.

We report here an attempt to widen the usage of these ECAD tools to achieve broader, and essentially educational, objectives.

EDUCATIONAL OBJECTIVES

In industry, the design of VLSI circuits is certainly the area in which ECAD techniques are most useful, and it is appropriate that students receive training and experience in this. However, the techniques can be used in a far broader context to enrich understanding and to promote insights more quickly and efficiently than through more conventional teaching material.

SPICE can be used to simulate analogue circuit behaviour and to show the sensitivity of the circuit to changes of key device parameters. These parameters are in turn dependent on the construction (processing) of the device. We have therefore developed a package whereby students can experiment with processing via simulation and determine the resultant effect on the device parameters and hence the overall circuit performance.

We believe this approach to be valuable for two reasons:

School of Electrical & Electronic Engineering, University of Bradford,
Bradford, West Yorkshire BD7 1DP, UK

a) It enables many fundamental principles of both physics and engineering to be illustrated with a flexibility that is not possible in a conventional laboratory or lecture course;

b) The philosophy is directly relevant to VLSI design and "serious" use of ECAD tools. There is an increasing trend in chip design to move away from simple gate array implementation, in which device parameters and performance are pre-determined, towards semi- or full-custom implementation, where understanding of the so-called design rules and the physical factors on which they are based, become increasingly important.

PROCESS SIMULATION

The Stanford University process simulation program, SUPREM, is a public domain package which simulates the various basic semiconductor processes, e.g. diffusion, ion implantation, epitaxy, oxidation, etc., involved in IC processing.

SUPREM pre-dates the era of workstations with their high resolution, fast graphics capabilities. We have improved the accessibility of the program to students by implementing an interactive graphics package on APOLLO workstations. Whereas a student would spend many hours or days on an introduction in the laboratory to even a few aspects of semiconductor processing, simulation enables fast and economical exploration of very many aspects of the subject. Since, obviously, processing technology underpins all integrated circuit production, we have taken the decision to introduce students to these ideas, and give them access to the processing package, in the first year of their course.

DEVICE PARAMETERISATION

Certain important device parameters (oxide thickness in MOS devices or base width in BJT's for example) can be calculated using the output from SUPREM. In general the link between the semiconductor doping profile (produced by SUPREM) and the device model parameters (needed by circuit simulation programs such as SPICE) involves a great deal of sophisticated semiconductor theory. Traditionally, these parameters are extracted analytically from simplified profiles (constant dopant levels, step junctions). However, numerical device simulation packages are available (e.g. SEDAN for bipolar transistors, MINIMOS for MOS transistors) and the use of these enables device parameters to be predicted for real doping profiles.

SEDAN is designed to be compatible with SUPREM, and will accept SUPREM output profiles directly. It is possible to specify a processing sequence, simulate through to the parameters of the resultant devices, and thus observe directly the effects on circuit performance of changes in process specification. However, using this route makes heavy demands on computing time: in any case SEDAN, being a one-dimensional simulation, is incapable of predicting the edge effects important in small-scale structures.

MINIMOS on the other hand is a two-dimensional simulator which produces parameters for MOS devices which predominate in digital integrated circuits. We are therefore in the process of developing an interface from SUPREM to MINIMOS so that the route from process to device parameters can be followed in a more realistic situation.

CONCLUSION

Many of the simulations described here are used by undergraduate students not as design tools as part of a design exercisee (the primary objective of the ECAD initiative) but rather as complements to cconventional experimental laboratory work. All of the work described – semiconductor processing, analysis of the process profile to the determination of device parameters and the measurements of the effect of these parameters on circuit performance -- could, given time and equipment, be performed experimentally. In reality, neitheer the time nor the equipment is available and it is difficult to see that there would bbe any advantage in physically performing the experiments if they were. The availabililty of powerful workstations and software packages enables a wider variety of "experimnents" to be performed in a much shorter space of time, to the benefit of students' unoderstanding.

We believe that such a programme is compplementary to, and supports, student work in the use of ECAD for VLSI circuit design.

APPLES IN THE GUATEMALAN HIGHLANDS

P.B.Scott*

ABSTRACT

An experience with microcomputers and Logo in a rural, indigenous primary school in the Guatemalan Highlands is reported. Students use their Indian language to talk about Logo, student interest is high, attendance has improved, and community support is strong. Some initial mathematics testing shows an advantage for the experimental school, but formal ways of measuring the sociocultural impact have not been determined.

INTRODUCTION

Apparently no experiences with Logo (or other educational uses of computers for that matter) have been reported from rural settings in Latin America. In July of 1986 Guatemala's National Bilingual Education Program (PRONEBI) began such an experience with two Apple II Plus microcomputers loaned by the University of New Mexico, and a version of Apple Logo that includes error messages in Spanish. A rural primary school in the Guatemalan Highlands was selected because it met two additional prerequisites: it had electricity and it had a teacher with some computer experience.

THE SETTING

Electricity is not common in rural primary schools in Guatemala. Fortunately, although the school does not have its own building (classes are held in rooms of a small church and in a rustic house), a major power line does pass near by and electricity is available. At the control school in another village less than two kilometers away there is no electricity. Both the experimental and control schools are small, approximately 150 students, and located in indigenous villages at almost 3000 meters elevation up a winding dirt road about 15 kilometers from the nearest city.

The teacher, Pedro, had been working in PRONEBI's Information and Evaluation Center in the Capital entering data on MS-DOS machines when he was offered a teaching position in the same department as his home village. Although the teaching position offered him more long-term job security, he was not sure that he wanted to leave his work with the computers. When it was suggested that he could take two computers to the school, his decision was made. He received a very short training session on Logo, a copy of Reggini's Alas para la Mente (Wings for the Mind), and was sent to integrate Logo into the school's curriculum.

---

*University of New Mexico

Pedro arrived at the village school to teach first grade. Many of the children in first grade speak very little Spanish and are much more fluent in their local Indian language, Quiché. Fortunately, Pedro, as a teacher in the bilingual program, also is a native Quiché speaker. The bilingual education program builds on the Indian language, develops literacy in that language, while at the same time presenting Spanish as a Second Language. Although the version of Logo they are using is Apple Logo with the commands in English and the error messages in Spanish, even the older students (all students in the school have a chance to use the computers) prefer to talk about their work on the computer in Quiché.

RESULTS AND CONCLUSIONS

The school has now had the computers for a year and a half. One purpose in putting the computers there was to try to discover something about the impact of the introduction of computers in a remote, rural Third World setting. Third World schools tend to suffer from inadequate physical facilities and a nearly complete lack of instructional materials. In this particular village the "school" did not even have its own buildings. It was housed in rooms lent by a church and in a small one room house. The one room house was divided into two classrooms by aluminum sheeting, but they had only one portable blackboard that was shared back and forth between the classes. As is the case in most rural villages, there is serious poverty. Many of the children come to school barefoot and in tattered clothing. That's right: no shoes, no regular school building, not enough blackboards, but now they've got computers.

We are still struggling with a way to measure formally the sociocultural impact of the introduction of computers, but other than some testing in mathematics, our efforts have been informal. Although the village is rural and poor, technology has already had some impact on the village. Almost all homes have radios and a few even have televisions. Some individuals in the village work in a rather strange aspect of the informal economy common in Latin America. They purchase Japanese-made electronic audio and video products in Guatemala and sell them in southern Mexico where they are not easily available. Among the other products that are sold in this clandestine trade are some medical products and hand tools. Obviously, although many people maintain residence in their traditional, indigenous village, they are involved with modern technology in the outside world.

Several informal observations can be made. The students really seem to enjoy the computers, and many come to school early and stay in at recess to use them. Although the last bus back to his home leaves the village right as school lets out, Pedro sometimes stays after school so the students can use the computers and then walks to the next town to get a bus. On one occasion I arrived early in the morning to observe the use of the computers only to find that an electrical spike had damaged both. I drove the long trip back to the Capital and returned with two replacements. Although it was two hours after the end of the school day, the students had remained waiting for the computers. The small first grade classroom more than filled as students and community members crowded in to see the demonstration. There is a sense that school attendance is up, but we have no long-term accurate attendance data. Community support has been excellent. Many adults from the community have visited the school in order to learn something about the computers. The teacher who has for years tried to interest the community in putting the pressure on government officials necessary to get a school built insists that with the arrival of the computers the community decided that they had to have their own school building so that they could protect their computers. New school construction is now underway and it should be ready for occupancy in early 1988.

At first some complaints were heard from teachers in other schools that it was wrong to use precious Program resources to buy computers while the schools lack basic necessities. Since it has been cleared up that Program resources were not being used, the criticism has subsided. Several other schools have now come to visit and their students have been treated to a demonstration of Logo given in Quiché. Someone from one of the nearby villages did complain that computers are not part of indigenous culture, but then again neither are the clothes he was wearing.

Pedro feels that it is important for the students to know that they can use modern technology in their own language. As he put it, "The fact that you speak Quiché, doesn't mean you can't use a computer." Having computers in the school has helped the children "lose their fear" of technology. Pedro insists that valuing indigenous culture also means you have to "balance it with what is useful from other cultures while rejecting what is not useful." Pedro points out that many indigenous institutions use computers. In fact the Quiché Writers' Association not only uses them, but is helping to provide the papers and ribbons used at Pedro's school.

As shown in Table 1, the mathematics achievement of the first grade students in 1986 improved significantly from July to October in comparison to a first grade class in the nearby control school. It is suspected, of course, that the improvement has as much to do with the new teacher as it does with the computers. Not only was he young, enthusiastic and providing them with computers, but prior to his arrival they had been in a much larger multi-grade class. Results of 1987 first grade mathematics testing should be available soon.

Table 1 Pretest-Posttest Scores in First Grade Mathematics

		Pretest		Posttest	
		Mean	S.D.	Mean	S.D.
Experimental Group	n=26	47.0%	19.8%	80.2%	13.8%
Control Group	n=43	50.1%	14.6%	42.9%	16.1%

Some other phenomena, often associated with computers in education in the United States, have been observed. The older girls in the school do not seem to be as interested in the computers as the boys, but in the early grade such a difference is not as pronounced. The presence of the computers in the first grade classroom sometimes is a distraction. Also, rural Guatemala's first hacker may have been identified. The sixth grade boy who showed the most interest in the computer neglected his studies and did not pass his final exams.

LABOR - LABORATORY ENVIRONMENT FOR LEARNING SCIENCES

L.A. BARROS*

ABSTRACT

It is presented the software and hardware project specifications of a learning tool wich will integrate in a single product several functions occuring in the academical laboratory activities (information gathering, text and graphic production, bibliographical retrieval, creation and use of tutorials, and connection to remote or local networks). LABOR is expected to be an active tool during experimental tasks through monitoring and measurement instruments in lab processes. This project is also intended to be inserted among other pedagogical environments where students can "build their own knowledge".

INTRODUCTION

To some educational experts, experiments are recognized to be an important activity in the study of science (ref.1).However, to avoid only mechanical tasks during the laboratory sessions, the student must find himself a special environment, in order to acquire a knowledge in this kind of class (ref.2).

In this learning approach, the teacher puts forward a problem and also prepares the environment to offer the student the necessary conditions to execute two main actions: 1-propose a project to solve that problem, through a succession of intermediate phases; 2-write a report justifying his decisions, analysing the data, and explaining his conclusions.

It is essentially during the experiment and its interpretation that the student reflects upon the data and reorganizes his knowledge. At this moment he can read theorectical texts and understand the formal explanations, really learning a new concept (ref.3).

Current technological development have influenced the design of a number of new measurement instruments simplifying laboratory activities. Among them, the microcomputer is used in data acquisitions, and also in the simulation of experiments.

However, available software helps only a certain number of experimental learning activities, and futhermore they come as isolated programes. This leads to several problems for the user, and the most important are: the data cannot be shared by the programes, so reformatitng routines and auxiliary files are needed; the functions are not orthogonal, which means for instance that the same keyboard key or function name may have different interpretations from one program to the other;-and different programes may require different microcomputers, hampering their usage in small laboratories.

Núcleo de Computação Eletrônica, Universidade Federal do Rio de Janeiro, P.Box 2324, 20001 Rio de Janeiro

LABOR is a laboratory station implemented in a microcomputer with some special interfaces and integrated software tools, to help the student and the teacher trough the creation of a special learning environment, during laboratory activities.

LAB-STATION MODULES DESCRIPTION

The main modules of LABOR are:

acquisition module - a hardware interface is designed to acquire data from experiments, with sensors dealing with temperature or luminosity gradients, or other specific laboratory measurements; it will have an analog-to-digital conversor, and software for saving data in user specified files;

statistical module - with tools as descriptive statistics, frequency distribution, contigency tables, correlation and simple regression analysis to help the student or the teacher in the examination of collected data;

simulation module - to evaluate the mathematical model associated with the experiment; the output from the simulation module can be saved on disk, expressed by a graphic, or compared with the measurement made by the acquisition module;

relational data base module - to manage tables of acquired or generated data;

text editor module - to provide an integrated environment to generate reports, making it possible to import data from other modules, as tables, graphics, and blocks of information from the tutorials; it may be used during the creation of tutorials with hypertext structure; and also help the teacher to propose laboratory activities and reports;

communication module - the lab station can be connected to local or remote networks;

graphic generator module - with routines to generate linear or bar graphics, and pie charts; the data may come from several sources: user input values, simulation, acquisition, statistical, and communication modules.

expert module - with a shell and a user friendly interface to store and retrieve the knowledge about the underlying experiment theory;

tutorial module - this module is an authoring-like system to store explaining texts using hypertext methodology (ref.4); this module is used by LABOR designers to create tutorials for each of its modules; this approach provides different levels of students interactions with the theory, oriented by his needs instead of the study of a predefined structured text about the subject;

LABOR can be installed according to course level, teacher pedagogical philosophy, or laboratory's hardware configuration. This is achieved by a layered-designed product, with a kernel of basic routines, a library of common functions; different modules each one with a tutorial for user self-learning or reference to a specific question, and an ergonometric interface under a user interface management system.

PROJECT DEVELOPMENT

Educational software and hardware must be developed in parallel with two important activities to guarantee their acceptance by the educational community and their correct use: 1-teacher training and participation during the software/hardware specification and evaluation phases; 2-curriculum analysis and, eventually, curriculum modification to bring about better use of this technology in the subject teaching/learning process.

LABOR/PHYSICS prototype is being developed with this approach. The development team is formed by systems analysts, teachers, and researchers from the GINAPE group and the Physics Institute interested in the practical teaching of physics.

One of the aspects being discussed by the team is the use of LABOR in the data acquisition activity. It is accepted that LABOR can help in this task, the student should understand and do himself, at least once, the experiment measurement, if possible. LABOR will be useful specially when difficulties arise, as very small or very large measurement time intervals. It is emphasized the importance of the student understanding the computerized process monitoring and the risks involved in transferring this task to the computer. The teacher must explain the related problems (lack of precision of the acquired values, hardware failure and power interruption during the experiment) and the reasons to substitute a computer for a human activity. He must also urge special care to avoid errors eventually introduced by the automatic measurement.

CONCLUSION

It was presented the design of a laboratory station with integrated software and hardware tools, to make possible the use of the microcomputer in all the steps of the work using the scientific and experimental methodology.

Despite the availability of some of the LABOR modules as separated programs in the software market, their use is not easy because of integration and portability difficulties. LABOR main advantage is to orthogonally integrate many software tools in a single environment, encompassing common services: context sensitive help service, tutorial call, operating system communication and module exchange.

LABOR approach is focused on pedagogical principles based on student-centered learning. However the teacher and student can work creatively in different steps of the experimental learning activities.

Finally, LABOR is not only designed for the teaching of science. Future developments includes a programming language, more sophisticated implementations of the hypertext-tutorial and the text editor modules, to be used by the humanities, making LABOR a generic learning station.

ACKNOWLEDGEMENTS

I am grateful for the following for their assistance in preparing this paper: F.Ferrentini, L.Nogueira, O.Alves, S.Helt (GINAPE group - NCE/UFRJ), L.Fagundes (LEC/UFRGS), R.D.Campos (LCG/COPPE/UFRJ), and J.R.Freitas.

REFERENCES

1 - R.Axt, V.C.Guimarães, Ciência e Cultura, 37,1, p39, (1985)
2 - B. Inhelder, J.Piaget, The Growth of Logical Thinking from Childhood to Adolescence, (Basic Books,NY,1958)
3 - D.Schatz, A.E.Lawson, Mercury,4,p6, (1976)
4 - J.Conklin, IEEE COMPUTER,20,9,(1987)

PHILOSOPHY OF TECHNICAL EDUCATION

Dr. Antonio Luna Arroyo

ABSTRACT

A review of the history of utilitarianism and pragmatism is offered in this paper. The purpose is to show the continuing pertinence of these ideas to modern technical education.

INTRODUCTION

There are two reasons why the philosophy of technical education must be considered from the point of view of utilitarianismand pragmatism.

The first one is that, in the high technology times in which we live, such philosophies, oriented towards what is useful and practical provide a coherent primary and ultimate explanation of our existence: they become a sort of total "cosmic vision" of contemporary man.

The second reason is that these philosophies prevent a confusion of the pedagogical concept with the materialistc view of man and the world postulated by Marxism-Leninism. Communists, indeed, with their "monistic" view of the worl, continue to think of utilitarianism and pragnatism as bourgeois philosophies.

We will be dealing with this subject matter making a special emphasis on technical education in Mexico and the United States. The reason is that the philosophical ideas which have guided education in both countries have their origin in the British utilitarianism of Jeremy Bentham, James Mill and John Stuart Mill, and in the American pragmatism of Charles Sanders Peirce, William James and John Dewey.

John Dewey, I should add here, was the initiaor of the "action school", which became particularly popular in Mexico.

- I -

Jeremy Bentham uses Kant as his departing point. Kant had underlined in his Critique of Practical Reason the importance of action in life when it is linked to the human will. Bentham wrote that the essential trait of a good action is that it be conducive to what is useful. What is good is what increases the total sum of wellbeing for the community. This implies, according to Bentham, an egalitarian view of society.

Bentham was criticized on his social views by John Stuart Mill, who called the former the "great subversive". Mill believed Bentham's concept of the human being was too narrow, since man not only reacts out of selfishness, love and hatred of other human beings. Mill claimed: "Bentham can only teach the means to organize and regulate the mere mercantile aspects os society's structure."

In the United States, Charles Sanders Peirce attempted to free Kant from the speculative part of his doctrine and explained world and life on the basis of practical significance of action. This concept he called "pragmatism" in his Studies in Logic.

The true founding theoreticians of pragmatism in education, though, were doubtlessly William James, John Fiske and Oliver Wendel Holmes. James argued that truth in knowledge is not a relationship between the real and the ideal, as traditional philosophers viewed it, but rather whatever promotes life, whatever is practically efficacious in achieving something. Fiske and Holmes, meanwhile, claimed that the object of their philosophical convictions was the practical effects these could have.

According to José Ferrater Mora, a Spanish thinker, there are "many European and North American philosophers who call themselves pragmatists, in spite of having defined their currents of thought with different names: instrumentalism (Dewey), experimentalism, functionalism and humanism.

George Herbert Mead claims that 13 sorts of pragmatisms have been registered. And these Arthur O. Lovejoy has classified in four different groups: (1) pragmatist theories of meaning, (2) pragmatist theories of judgement validity, (3) pragmatism as epistemology, and (4) pragmatism as ontology.

- II -

In view of what we have said so far, we can now plunge into the subject of pragmatism in technical education.

It was William James who, following Peirce's pragmatism, told us that "we must reduce truth to utility and reality to spirit in order to clarify our ideas". In this, James manifested a kindred disposition to that of French spiritualists, such as Henri Bergson. Indeed, James's pragmatism is tinged with a psychological hue. This psychologism is also the basis of a rationality which, according to James, is a sort of intuitive feeling (The Will to Believe).

Pragmatic philosophy goes even further with Dewey. According to Dewey, philosophy must find out what nature is in order to dominate it and put it to purposeful use. It is not a contemplative task, but rather activity at the service of life.

Pragmatic thought, according to Dewey, is an instrument of readaptation: it is a bodily organ, just as arms or teeth.

"Thought is an instrument of life control," he writes, "a tool which man uses in its struggle to exist. An idea is true in so far as it is an effective instrument to explain experience and to realize human objectives."

In the field of education, Dewey supported the ideas of a social democracy. "Only an inteliggent system of public education," he claimed, "may combat differences in fortunes the existence of vast masses of unprepared workers, the scorn for manual labor, the lack of capacity to acquire an education that will put people in a position to forge ahead in life."

In the particular case of Mexico, Dewey proposed a pragmatic (instrumentalist) pedagogy of action, psychogenic and socially oriented.

Before we conclude, we must make mention of pedagogy in a techonological time such as the one we live in.

With the use of equipment in the transformation of raw resources, man acquired a new relationship with traditional cultural and spiritual values.

The circumstances surrounding present-day technical education are: (1) a struggle against uniformity in the formation of contemporary man, since industrial production is oriented more towards quantity than quality, at a time when machine work and the introduction of computers have led to a systematization of life, and the spreading of mass communication media has at last created a global village; and (2) a struggle to ensure that new technical and scientific discoveries do not destroy the principles of humanistic education.

In this time and age, when labor-saving devices have expanded leisure time, it is important that free time continues to lead to esthetic pleasures, religious traditions and human coexistence in an interrelating world (in the family and the community, at the local, the national and the international levels). It is also important that efforts continue to limit arms confrontation, in order to guarantee the achievement of Bentham's objective: that industru guarantees the greatest possible happiness for the largest possible number of people.

-III-
PHILOSOPHY OF TECHNICAL EDUCATION

Based on the philosophical theories described, Mexico's public technical education system offers programs for professional formation of students at three academic levels with different technical options.

The first, basic, middle school, provides schools for students who have completed six years of grade school. These schools in addition to teaching the regular basic-middle-school curriculum, also teach technological skills in three different fields. 1) Industrial technology and administrative services (ETI), 2) fishing technology (ETP) and 3) agropecuarian technology (ETA). At this same level, there are two terminal training centers for 1) industrial work (CECATI), open to factory workers and 2) agropecuarian work (CECATA), open to farm workers.

The second level, superior middle school, is open to students who have finished their basic middle school. There are six options at this level. 1) Scientific and technical studies (CECYT) and 2) forest technology (CETEF) are both schools with a curriculum to go on to higher education as well as a curriculum to provide the students professional training in industrial and service skills in the case of the CECYTs and in forestry in the case of the CETEF. A third option is either the Center for Industrial Technology and Services (CEBTIS) or the one for Agropecuarian Technology and Services (CEBTAS). 4)Ocean Technology (CECYTEM),5)Agropecuarian Technology (CETA) and6)the Technological Industrial Centers (CETI) are terminal level schools. In other words graduates of these schools may not continue on to higher education.

Finally, the third academic level, university level, has the National Polytechnic Institute which is the second largest institution of higher education located in the Federal District. This institution has several schools offering B.A., Master and Ph.D level degrees. It is the institution which sets the philosophical foundations for the complete sector of the National System of Technical Education in the country. At this level there are also the Agropecuarian Technological Institutes (ITA) which offer B.A. degrees in the fields of Agriculture, Forestry and Husbandry. The Ocean Technological Institutes (ICYTEM) offer B.A. degrees in fishing only while the Technological Institutes (IT) offer B.A. degrees in different areas of engineering, administration and architecture. At this level there is also the Research Center of Superior Studies (CIEA) which is the institution of research for technological studies and which offers Master degrees.

Of course the universities throughout the country, both private and public also provide technical education, but for historical reasons, for which there is no time to deal with at this time, these institutions are considered under the university sector and not within our National Technical System of Education.

Our technical education in Mexico relates its educational plans to the reality of our socio-economic development and thus one of its main objectives is to link its programs to the industrial and productive sector of the country as a whole complying with the philosophical principles of pragmatism and utilitarianism.

Antonio Luna Arroyo and Corina Schmelkes

BUILDING AN INFORMATION TECHNOLOGY INFRASTRUCTURE FOR THE POLYTECHNIC OF CENTRAL LONDON

Ewan Sutherland[†], Dave Roberts[‡], Chris Maslen[‡], Ben Anrep[‡], Bob Lowndes[§]

ABSTRACT

PCL is developing an improved IT infrastructure based on OSI, which is expected to run over a fibre optic wide area network linking several sites in London. The principal uses for the network are (1) practical teaching sessions and student access to host computers and the OPAC (2) support for central and faculty administration and (3) administrative support for academic staff. A new electronic mail system is being specified using X.400. FTAM will be available for back-up of PC's, file servers and mini's at local sites and for access to data files from remote sites. Improvements to the telephone network through the incorporation of voice into the data network were considered. New links have been built up between the staff in Computer Services and users.

INTRODUCTION

The Polytechnic of Central London (PCL) is currently undertaking an Open Systems Interconnection (OSI) Opportunity Study to examine how products conforming to OSI reference model could be used to develop and to improve IT infrastructure. The chance of funding from the Department of Trade and Industry for this study prompted us to look at longer term issues than the more usual "fire-fighting". The study examines in detail networking and electronic mail. The aim is to produce an OSI profile and architecture for the provision of network services to users. [1]

PCL was created from a number of institutions, centred on the "Regent Street Polytechnic". Consequently it has inherited a number of sites in central London, to which it has added more. Property costs in central London have made it impossible to consolidate onto a single site.

After many years of funding through the Inner London Education Authority (ILEA), PCL will shortly be given independent status funded by the Polytechnics and Colleges Funding Committee (PCFC). [2] Funding for both revenue and capital is short term and highly unpredictable.

The incorporation of IT into courses is a function of the knowledge, experience and willingness of teaching staffand the availability of support staff. The decision to change or to increase the teaching of IT hinges critically on their experience of IT and their perceptions of available and obtainable facilities. As the use of new IT systems diffuses into and through PCL, the IT content of courses rises in quantity and, invariably, in sophistication.

Use of IT in management has also grown through the development of management information systems, word processing and some use of spreadsheets and electronic mail.

HISTORICAL DEVELOPMENTS

Computing at PCL was originally centred on the Faculty of Engineering and Science. Over many years it has grown to encompass all faculties and most administrative activities, in doing so its nature and scope has widened considerably.

The growth in demand for processing power and, to a lesser extent, disc space far exceeds supply. Central facilities are the subject of demands which could not be met in conventional hours (09.00 to 21.00), a night teaching shift would be necessary, if impractical.

[†] Polytechnic of Central London, Faculty of Social Sciences and Business Studies, 32 Wells Street, London, W1P 3FG, United Kingdom

[‡] Polytechnic of Central London, Computer Services, 115 New Cavendish Street, London, W1M 8JS, United Kingdom

[§] Eosys Ltd, Clove House, The Broadway, Farnham Common, Slough, SL2 3PQ, United Kingdom

The result is that faculties are able to book only a proportion of the terminal hours which they require. They are dissatisfied with this and attempt to play the system, by bidding for even more time. Moreover, it is technically difficult to guarantee bookings made of central hosts This has also caused a movement to PC's initially for progam compilation and more recently for graphics and statistics. Delays in replacing the DEC-10 have resulted in growing dissatisfaction with the software available on that machine and further encouraged the transfer of work to PC's. Additional demands have resulted in PC's being used heavily for word processing and spreadsheets.

Integration of PC's into an overall network will significantly improve the quality and flexibility of the services provided. It will also permit more selective use of central hosts.

Given that so much of the teaching consists of large blocks, relatively few changes can have considerable effects on demand and therefore on performance.

The existing network has been built up since the late 1970's, linking eight sites to the central facilities at NCS It is a proprietary network supplied by CASE designed as a terminal switch. Inter-site links are by British Telecom KiloStream. There is considerable growth in the use of LAN's at individual sites and departments. The need for a better network has been recognised for some time, to provide improved and more flexible services.

The Joint Network Team has developed its Transition Policy towards OSI. Given PCL's long-standing connection to JANET and the desire to remain connected, it would have been impossible to ignore OSI altogether, at worst gateways would have to have been built. [3]

REQUIREMENTS ANALYSIS

The information required for this study was gathered by a series of over twenty semi-structured interviews with senior staff in the Rectorate, all faculties, Library Services and Computer Services. These interviews identified current uses, current problems, immediate needs and perceived longer term requirements. It was recognised that the results would be incomplete with respect to current issues and somewhat tentative about the future. Interviewees were asked to identify the importance and relative priorities they attached to individual services.

The requirements were then grouped into applications areas in terms of the OSI application layer services and the necessary underlying telecommunications infrastructure.

ELECTRONIC MAIL

Practical internal communication difficulties arise because PCL has so many sites, has a large percentage of short course and part-time students and a poor telephone service. External links to other polytechnics, universities and, increasingly, to industry and commerce are important.

Knowledge of the existence of electronic mail is high, although there is rather less experience. It was already seen as a potential solution to the problem of staff communicating with staff. However, one prerequisite for this would be an adequate supply of terminals to which staff would have easy access.

Terminal access for students is a much more serious problem. It is so grave that, combined with the broadcast nature of much of the traffic, a public videotex service with colour monitors in public places would be preferable. Such a service could be made highly visible, without the need to install large numbers of terminals in halls, common rooms, etc. Messages could be tailored to sites to avoid those unrelated to potential viewers. Moreover, it could be linked to systems messages and bulletin boards on remote hosts. Links to students and staff working off "campus" or at home would be important (see below).

Physical delivery of electronic mail would be extremely important to those not on the electronic system. This could be achieved by laser printers in post rooms.

The impending opening of the gateway from JANET to BT's Gold 400 will permit connection to users of commercial electronic mail services in the UK and overseas. It will also allow telexes to be sent and received.

Immediate benefits could be obtained by extending electronic mail to personal computers and local area networks. There remains considerable scope for development of use in the existing systems. However, these are unfriendly and have inconsistent interfaces. The replacement system should be easier to use, particularly given the growth in users who will not be IT "experts".

Further developments in the standards for the directory service will be awaited to provide an important element in provision of an electronic mail service.

FILE TRANSFER AND ACCESS MANAGEMENT

File transfers do not appear to be in demand by the majority of users. This is primarily because they have their data and software on one machine or one system, though there is some use of FTP (from TCP/IP) and Kermit.

A major growth area is in centralised back-up facilities. Only at one site is there demand for back-up facilities, other than at the Computer Centre. This will shortly expand to several sites with the installation of mini-computers and network file-servers. The existing network will not permit such large and regular quantities of data to be transferred. Consequently it will be necessary to buy local back-up equipment and allocate staff time to this task.

Designers of library systems are looking to, and gradually adopting standards for bibliographic data and inter-library lending. This is likely to represent a significant volume of traffic to and from JANET. In addition to off-site databases there is considerable growth in the range of databases which can be held on-site, e.g. Micro-Exstat. The problem these represent is how to provide access to them.

In the longer term, consideration will require to be given to the OSI database standards.

VIRTUAL TERMINAL PROTOCOL

Implicit in all applications run on remote hosts is terminal access (other than those using JTM). Whilst it is clear that there will continue to be exponential growth of use of PC's it cannot be concluded that the more linear growth of terminal use will cease.

It is likely that many of the bulk applications on remote hosts will be transferred to networks of PC's. However, users will still want access to central facilities from time to time, notably electronic mail and the Online Public Access Catalogue (OPAC). It is therefore likely that the total number of terminals (including PC's emulating terminals) will grow, but that the average use of each workstation will decline. The PC's are likely to be fairly heterogeneous, albeit mainly of IBM-PC type.

Terminal access will be required to remote hosts on JANET, including OPAC's.

JOB TRANSFER AND MANIPULATION

At present there are no facilities for the remote submission and execution of jobs and very modest demands on local hosts. It is not foreseen that this will change.

NETWORK MANAGEMENT

The "new" network will require to be both more controllable and more flexible than the existing network, e.g. bookings. More information for management and planning will be required - especially given the expectation of continuing growth in traffic.

In practical terms, given likely availability of funding, it will be necessary to phase out the existing network in stages, meanwhile providing an orderly transition to the new service. This is important to maintain at least the existing quality of service and to retain and build on staff skills.

Again, the development of the network management standards is awaited.

NEW NETWORKS

Ideally, the network should be a seemless web, incorporating the inter-site links and the growing number of local area networks, together with gateways to JANET and beyond. However, this is unrealistic given likely product availability, costs and the degree of heterogeneity of the attached systems.

The availability of fibre optic links at modest cost opens the way to broadband intersite communications with integrated voice and data. This removes the duplication of the separate voice and data services. It also provides greater flexibility in providing access to data services through PABX's. Given the much greater bandwidth of optic fibre cables it appears to provide a modest element of future-proofing, in that any prediction of use falls far short of the available capacity.

There is an increased requirement for access from home with more links to the telephone network. For those out of London, calls should be made to local universities and polytechnics from where they should be routed over JANET, though this will require the agreement of the institutions concerned.

CONCLUSION

It is much easier to manage a central monolithic resource than a diffuse one. It is comparatively easy to impose and to enforce controls on the purchase and connection of IT. However, it is much more difficult to persuade users that the constraints are necessary and appropriate. Giving advice to users is very difficult, especially where ther is a shortage of skills and the cultural differences between IT "experts" and "users" are so great. [4] All these problems and more are faced in implementing the proposed changes.

The aims are to provide services to users at all sites in terms of the OSI Application Layer. The provision of such services to a very heterogeneous population of workstations requires a sophisticated transport service. The provision of that service requires a physical infrastructure of considerable bandwidth, flexibility, scope and manageability. We are currently finishing the detailed planning of that network. The real challenge is to implement it.

Acknowledgements

To the Department of Trade and Industry for financial support to carry out this work and to Jim Craigie of the Joint Network Team for his help and technical supervision of our work.

Trade Marks

IBM is a registered trade mark of International Business Machines. DEC is a registered trade mark of Digital Equipment Corporation. CASE is a registered trade mark of Case Communications Ltd.

References

[1] Ewan Sutherland, Dave Roberts, Chris Maslen and Ben Anrep "Planning an OSI Network for a Polytechnic" Internal Paper.

[2] "Education Reform Bill" (HMSO, London, 1987).

[3] Joint Network Team "Transition to OSI Standards; Final Report of the Academic Community OSI Transition Group" (Joint Network Team, Didcot, Oxfordshire, 1987).

[4] Ewan Sutherland and Yves Morieux "Managing Telecommunications" *Computer Networks and ISDN Systems*, 1988 (in press).

COMPUTERS IN VOCATIONAL TRAINING - AN ESCALATING ACTIVITY

R. N. WILSON*

ABSTRACT

The acute shortage of adequately trained personnel (ref 1) to fill information technology (IT) related positions in industry, commerce, government and education demands the provision of carefully designed course programmes, to produce graduates with skills and training appropriate to the economic requirements of the community. Through this paper, an overview of the role of proprietary software systems in the provision of vocational training, at both diploma and undergraduate level, at the University of Ulster is presented. The associated supportive services offered by University Computer Centre staff is also reviewed.

INTRODUCTION

The University of Ulster, formed in October 1984 by the coming together of the New University of Ulster and Ulster Polytechnic, is the newest of the United Kingdom (UK) Universities. Degree and diploma courses at both undergraduate and postgraduate level are offered on four campuses situated throughout Northern Ireland (NI). The innovative nature of the course programme is a reputation inherited by the University from the Ulster Polytechnic. First degree courses are, in many instances, designed to incorporate periods of professional training in industry, commerce or public services, or time spent abroad; for example in business and language courses. A rich blend of academic and vocational input may be found in the syllabus of many courses.

The computer and its use through applications is also an integral part of an ever-increasing number of courses spanning the faculty structure of the University. A major element of computing is now associated with the use of commercial software as part of a course unit, workshop, assignment or major project. The Computer Centre offers students an effective and efficient environment within which they can gain an understanding of information technology as it affects their profession. The following sections of the paper address both the software provision and related activities.

PROPRIETARY SOFTWARE AND AREAS OF USE

The Computer Facilities for Teaching in Universities Report (ref 2) refers to use of commercial software although the areas of use are limited to Computer Aided Design (CAD)/Computer Aided Manufacturing (CAM), Data/Statistical analysis, databases and text processing.

In practice, commercially available software has a much deeper penetration within our institutes of higher and further education. At Ulster there are at least 50 packages available, many being Departmental purchases for specific teaching or research activities. Because of the number of systems available and their broad usage it is not feasible to refer to each in this paper. Systems which are not widely known nationally, and which are the basis of vocational training in a number of courses are documented.

The Faculty of Science and Technology is the major user of commercial software; a direct reflection of availability levels, if microcomputer-based systems are excluded. In addition to usage of many popular systems there are several other more specialist items in use and being installed. Within the Department of Building where there is a research interest in fire safety modelling, software for this application has found its place in the undergraduate programme. Two recent software acquisitions, from the United States, deal with fire safety modelling in buildings and design of buildings to conform to file regulations. The Department of Transport Studies have access to several packages, for example the ship design and analysis suite, SFOLDS, from British Maritime Technology, UK; the highway design and budgeting model, developed and used internationally by the World Bank; city transport design and simulation software and an operational research-based suite of general transporation problem solvers marketed by Wooton Jeffreys. Civil engineering applications extend beyond traditional finite element and drafting applications to include soil mechanics, using BISHOP, and reinforced concrete design, using GLADYS; both systems marketed by Strucom Ltd. Mechanical engineering is also well catered for commercially; recent research robotics within production engineering has made use of discrete and continuous simulation software. ENPORT6 and SLAM, both American packages, have been acquired and their level of application is expected to increase once sufficient expertise is gained. The recent IUSC initiative associated with electronic computer aided design (ECAD) will be of benefit to both the Departments of Physics and Electrical and Electronic engineering. Chemists use the GAUSSIAN-86 package in quantum chemistry applications (this package has its origins in Carnegie-Mellon University); there is an interest in the acquisition of molecular modelling software.

---

* Computer Centre, University of Ulster, Shore Road, Newtownabbey, County Antrim, Northern Ireland, BT37 0QB

Use of commercially available software within Business and Management is influenced by the computing facilities normally required by small and medium sized businesses; that is those for a microcomputer or networked microcomputer system. The Faculty have made several software and hardware purchases to provide student facilities of this nature. Use of the central computing service is associated with large-scale surveys, using SPSS-X; econometrics, using the time series package TSP; financial modelling, using FINNESSE, and discrete simulation of production processes, using HOCUS, both marketed by PE International.

Art and Design students use a number of packages. Pattern generation, graphics design and information graphics in advertising are supported by PICASO, which has been used for over 10 years, and the solid modeller within the I-DEAS CAD/CAM suite. This solid modeller has experienced several innovative applications, particularly in the use of boolean operations to create logos, some of which have been successfully entered for competitions; and the logical manipulation of a series of geometric shapes to form 3 dimensional objects (for example, the use of a cylinder and sphere, appropriately transformed, to generate an apple). The subject of new product design is now to be offered through a new Postgraduate diploma; the teaching method will be project based and it is planned to make extensive use of a range of computer-based applications associated with product design and development, including design, draughting and production of promotional materials.

The areas of Social and Health Sciences and Humanities tend to be well serviced by either proprietary statistical analysis software, for example, the SPSS family (SPSS-X, SCSS, SPSS Graphics and LISREL), MINITAB and GLIM. The range of commercial systems in support of applications embraced by the disciplines within the remit of these faculties are limited, and market trends dictate microcomputer-based facilities whenever they do exist. Exceptions include career guidance training which is supported by JIIG-CAL and GRADSCOPE and language structures and parsing applications, undertaken by the Linguists Database (LDB) marketed by university of Nijemegen, Netherlands. Usage of this latter facility has not commenced as it is the most recent acquisition. Initial use will be at research level but if previous trends are followed, project work and limited course work will be introduced at undergraduate "applied languages" level in future years.

The above paragraphs review, in brief, a number of specialist applications; there are however a number of other applications which are difficult to classify by Faculty. For example, the GIMMS geographic information and mapping package has been used by geographers, econometricians and surveyors for projects associated with the representation of data in a spatial dimension. The work relates to a variety of applications including property price analysis, economic and census-related work. Use of database facilities are yet in their infancy; the SIR suite has recently been acquired and it is planned to interface this system to data sets, being accumulated by social scientiests, for survey and statistical applications. The ability to structure data and interrogate it in a structured manner via a query language are seen as appropriate activities consistent with the requirements of 'large data" users independent of their subject specialism. Clustering techniques, experimental design and analysis and multidimensional scaling are other general applications supported by specialist software, which experience occasional use. Through our software usage monitor it is possible to detect trends in usage of these systems which relates to research projects, and undergraduate spinoffs, which are ongoing at particular times.

In concluding, the usage of materials acquired in the past 1 - 2 years is as yet limited; this is mainly due to advance planning in support of new courses. The future will be a period of consolidation, as far as many current facilities are concerned, but also one of expansion as even more courses embrace computing in a vocational capacity, and as the national negotiating scene brings even more relevant facilities within our financial grasp.

THE ROLE OF THE COMPUTER CENTRE

The Computer Centre maintains a comprehensive program library offering a variety of programs, which have either been developed internally or acquired. A major growth factor associated with the library is focussed on the provision of proprietary systems addressing the vocational aspects of both new and revised courses. Negotiations for appropriate educational conditions of use are undertaken by academic staff, in association with the suppliers; Computer Centre staff acquire the materials and integrate them within the computing environment in a way which induces effective use by (trainee) student users.

Installation of many proprietary systems, using supplied instructions, normally assumes that the target computer system is either a specialist service, for example Computer Aided Design (CAD), or used by specialist staff with in-depth computer systems expertise. A Computer Centre whose responsibility is to provide a University-wide service cannot normally comply with these installation conditions and must therefore tailor the installation to conform with the standards imposed on the service it offers.

The versatility of the Digital Equipment Corporation (DEC) VMS operating system enables sophisticated software interfaces to be implemented. Typical interfacing tasks include the provision of menus when a suite of programs constitute the package; validation of use-specified data, for example, input data file names; automatic facilities for management of results, for example, streaming of printouts and creation of hardcopy graphics.

The availability of supportive documentation is a further resource-demanding function. At Ulster there is a definite trend towards machine readable text. A four-tier information service is offered; an abstract (or help) facility; a summary sheet providing 'local' information, an introductory user guide and proprietary manuals. It is not uncommon to acquire supportive documentation consisting of several volumes. Direct use of this level of documentation by students who are frequently only required to use a subset of facilities is inappropriate. Academic staff, in association with the Computer Centre, develop user guides containing relevant information and illustrative examples, to supplement classroom tuition of the use of the systems. Production of supportive documentation is also a positive route to gaining initial skills and experience in the use of the software, particularly for Computer Centre staff.

A major difficulty however, is the ability to extend advisory service and consultancy duties to respond to queries arising from the usage of proprietary systems. Only in instances where software experiences regular usage at a moderate level throughout the academic year, is it reasonable to expect Computer Centre staff to become familiar with its operation. Lack of the associated subject specific background is an inhibiting factor in acquiring expertise. A training course is in many instances a prerequisite to purchase of systems but it is often accepted that maximum benefit to the institution is obtained by nominating academic staff to attend (ref 3). They have the advantage of contacts with the software specialists and find associated training materials useful in the construction of their course units. Over the past five years the rate of acquisition of commercial systems has been such that the Computer Centre can only advise on access procedures; the complexity and specialist nature of several packages inhibits familiarisation with their features. Student support and guidance has been the responsibility of academic staff.

SOFTWARE USAGE STATISTICS

The figures provided are for the period 1986-1987 at the Jordanstown Campus; the largest of the University with approximately 600 academic staff and 4,500 "full-time equivalent" students. There were 1972 registered academic computer users; 332 (16.8%) academic and research staff and 1640 (83.2%) students. A total of 37,404 library program accesses were recorded, 20,904 (55.9%) being associated with proprietary software. A total of 24 accountable systems were available on campus at the commencement of the year, with a further 5 installed during the period. The overall total of packages within the University was 50 in the same period.

Table 1 provides an analysis of user by faculty. Table 2 contains a breakdown of software usage by faculty and Table 3 indicates the usage levels associated with the "Top 10 proprietary systems". These statistics provide a picture of software utilization within faculties. An analysis by course and year of course has not been included. Program complexity, and consequential erroneous jobs, versus the extent of successful jobs is not possible to determine, at present. The high student utilization figure for GIMMS yields a value of 52 accesses per user; this statistic is known to reflect a high error rate, whereas the value of 7 for SPSS more accurately measures the usage level. (Typically students would have 2 or 3 erroneous jobs). Software whose usage was restricted to a single course-year group consisted of GUTS, SFOLDS and I-DEAS; whilst TSP, HOCUS and GENSTAT are known to be used specifically within the final year of first degree courses and at postgraduate level.

CONCLUSION

The acquisition and effective use of proprietary software, in response to the need to adequately prepare students for an information technology conscious society is a demanding task for both academic and Computer Centre staff. Financial implications which extend beyond procurement costs to training programmes, hardware costs, documentation and increasing usage of computing resources must be carefully controlled and monitored. Indeed sharing of expertise and resources, on a national basis, may very soon prove to be a practical proposition where "centres of excellence" could be established for a series of the more popular systems. The already well established inter-University computer network providing a useful vehicle for electronic transfer of machine-readable documentation and access to "subject specialists' for assistance and support. Furthermore, the trend already established by both the Association of Computer Users in College of Higher and Further Education (ACUCHE) and Inter-University Software Committee (IUSC) in provision of training workshops (ref3,4) could facilitate staff training at a lower cost per person than a comparable service from software vendors.

Overall, the trend towards increasing demands for, and usage of, proprietary systems has been established; it is now important to seek methods of cost-effective support and inter-University exchange of expertise.

TABLE 1 - BREAKDOWN OF USER BY FACULTY

FACULTY	USERS Staff	Student
Science & Technology	145	813
Informatics	57	276
Business & Management	44	210
Social & Health Sciences	60	224
Education	15	64
Humanities	4	20
Others	7	33
TOTALS	332	1640

TABLE 2 - SOFTWARE USAGE BY FACULTY

FACULTY	USAGE Staff	Student
Science & Technology	1261	5758
Informatics	67	7
Business & Management	482	701
Social & Health Sciences	337	10669
Education	404	118
Humanities	26	0
Others	1074	0
TOTALS	3651	17253

TABLE 3 - USAGE LEVELS - "TOP 10 SYSTEMS"

SYSTEM	USER STAFF		STUDENT		TOTALS	
SCSS	52	(1.4)	9405	(54.5)	9463	(45.3)
GIMMS	417	(11.4)	2809	(16.3)	3274	(15.7)
SPSS	803	(22.0)	1849	(10.7)	2757	(13.2)
TSP	242	(6.6)	1575	(9.1)	1876	(9.0)
SPICE	141	(3.9)	564	(3.3)	711	(3.4)
HOCUS	511	(14.0)	12	(0.1)	523	(2.5)
I-DEAS	450	(12.3)	28	(0.2)	503	(2.4)
GENSTAT	176	(4.8)	211	(1.2)	408	(2.0)
SFOLDS	10	(0.3)	307	(1.8)	357	(1.7)
GUTS	13	(0.4)	165	(0.9)	185	(0.9)
OTHERS	836	(22.9)	328	(1.9)	847	(2.9)
TOTALS	3651	(100.0)	17253	(100.0)	20904	(100.0)

REFERENCES

1. H Connor and R Pearson, Information Technology Manpower into the 1990's, Report of Institute of Manpower Studies, University of Sussex, Brighton, United Kingdom (1986)

2. D Nelson (ed), Report of a Working Party on Computer facilities for teaching in Universities, Computer Board for Universities and Research Councils, United Kingdom (1983)

3. L Burbridge, CAD/CAM software and application: IUSC Workshop, University Computing 9, 117 (1987)

4. ME Williamson, IUSC News, University Computing 9, 125 (1987)

NOTE

Addresses of software suppliers have not been included due to the limitation on the length of the paper; further details are available from the author.

DISCRETE FORMALISMS AND THE ENSEMBLE MODELING OF THE INSTRUCTIONAL PROCESS

Paul Prueitt*

ABSTRACT: The modeling procedure presented in this paper, based on a generalization of boolean formalism, may have enough richness to provide descriptive models of the instructional/learning process. Mathematical models of the processes involved in cognition provide a basis for future value added measures of the instructional processes. We are, however, a far distance from understanding general cognitive processes. This paper suggests a general procedure for constructing models of cognitive processing. Such models can provide a basis for understanding such processes as they occur in the university classroom.

INTRODUCTION

The future professional discipline of university mathematics education will require the successful implementation of a technological basis for disseminating basic mathematical knowledge to the general society. This will not be done until a truly revolutionary theory of learning is developed. Good descriptive mathematical models of university mathematics instruction may be used to alter present trends which automate the instructional processes without fully understanding the intellectual needs of the student. This paper introduces a general procedure which formally constructs models of those adaptive processes playing central roles in the instructional/learning activities. Basic components of such models are naturally the various sub-models of the learning process, of the teaching process, and of the interaction between these two processes.

SECTION ONE

Transient state homologies, a correspondence between the state transition diagram and the transient states of nonlinear differential equations, has been useful in building models of adaptive processes such as immune response (Ref 4). The procedure was developed to provide continuous nonlinear differential equations which qualitatively match constraints on the population dynamics. It develops difference equations from discrete formalisms and then constructs a continuous system of differential equations.

Discrete formalisms are a generalization of boolean formalisms (Ref 13) and allow the construction of dynamical systems from the finite information contained in a state transition diagram (see Figure 1a and 1b). Where some specific dynamics are well known then derived network equations, such as adaptive resonance equations (Ref 2), can be coupled to the formalism. The nonlinear equations (Equations 1-3) are derived by our procedure and provide a parameterized family of models each member of which has an ensemble likeness to the diagram. The modeling procedure is minimal (Ref 6) in that distinctive behaviors of sub-processes are matched in a formal transient state homology. Analogy between the discrete dynamics on a generalized hypercube and the continuous dynamics of the derived system of differential equations allows us to model specific sub-processes associated to learning or to the internal representation of knowledge.

*Mathematics Department, University of Texas at Arlington

We wish to model learning processes as they occur in the college classroom. The state transition diagrams (Figures 1a and 1b) are abstract discrete models of a system dynamically maintaining information in finite state mechanisms. The model reacts to stimulus by altering biochemical production models from one mode to one of a finite number of other production modes. In this model the information is thought to contribute to complex mechanisms which have input from many substructures and are non-local and are thus possibly holographic in nature (Ref 12).

As an illustrative example we present here a model of ensemble selection existing as sub-processes of synaptic transmission. As a descriptive model of abstract information processing mechanisms, formal multi-state logics allows us a procedure for modeling what is by definition very complex. The model (Equations 1-3) can act as a single processing unit within the context (and functional definition) of larger network based dynamical systems.

Our procedure builds a model in which the dynamics of a single unit will always have stable limit cycles. The nature and type of chains and cycles will depend logically on an arbitrarily selected state transition diagram. The central invariant feature of my present example is the core regulatory circuit (Figure 1a). State sequences on the branches (Figure 1b) are stored (through a Hebbian like rule) and thus may have a degree of variance from one unit to another. The synaptic events are described by Pribram to be polarizations generated in the dendritic networks of the brain. If the events naturally form discrete event states, then the model building procedure (Ref 5) will work.

During the 1950's and 1960's, following the lead of Donald Hebb (Ref 8), neurophysiologists accumulated evidence that the basic element in computational processes within the brain is the single neuron or small clusters of neurons. Neuronal computation was the passage of energy patterns through a network of neurons. Memory was thought to be based on the transmission strength of the symmetrically connected network (via synapses). This paradigm received support from the early work of Minski and Papert (Ref 10), McCulloch and Pitts (Ref 9), Rosenblatt (Ref 11) and from the analogy which existed between the computational units of the electronic computer. A number of problems have continued to remain for this paradigm. Memories seem to be distributed in such a way that memories are not lost due to cell renewal. Another problem is how fine detail can survive extended histories given a limited space on which to map a continuum of experience. Still another problem involves imaging an external world which is not composed of a small number of basic units.

The imaging problem is somewhat overcome by considering layered networks and clusters of sub-processes based upon subneuronal and neuronal networks. Another step may be made by regarding the information being processed or maintained as interference patterns generated by a mapping of the sensory information onto a space which is defined by Fourier series. One more step moves us to the holonomic brain theory of Pribram in which information is seen as holographic information stored and processed via dendritic (subneural) microprocessing. Mathematical models which are consistent with holonomic brain theory include those that use topologically invariant pattern formations as local minima of dynamical systems of coupled rotators (Ref 1) and the adaptive resonance theory of Steven Grossberg (Ref 2 and 7).

The local mechanisms responsible for encoding and transmitting information may indeed be based on the states of subsystems of the post-synaptic junction (Ref 3). This possibility is implied by the presence of structured information encoded in brain tissue and which reflects genetic information. Primary and secondary repertories of feature detectors are thought to adapt in a Darwinistic fashion to the process of living in the world (Ref 3).

SECTION TWO

Consider the state transition diagram (Figures 1a and 1b) which show a discrete and deterministic rule for the state of an abstract system at time t + Δt given the state of the system at time t. Δt is normalized by conjecturing that the system changes its state instantaneously from one of the system states to another and then exist in that state for some period of time. In the model there are 12 states of the system corresponding to three variables which define the sub-processes.

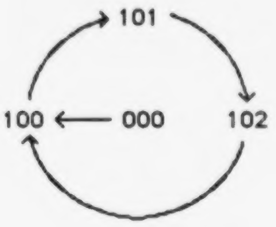


Figure 1a

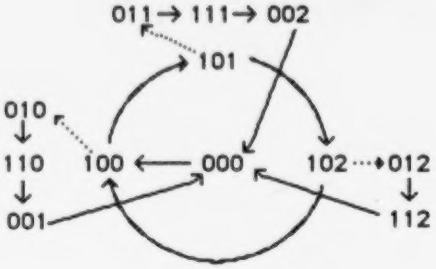


Figure 1b

In Figure 1a the state sequence 000 → 100 → 101 → 102 → 100 → forms a basic core circuit. Figure 1b shows transitions from this circuit to associations in memory.

The state 000 is thought of as a category representation with associated holographic codes 100, 101 and 102. These codes are dynamically activated by an evolution determined by the energy state of the core circuit as the system passes through the energy states in the limit cycle 100 → 101 → 102 → 100 → . The state 000 is activated by sensory stimulus or internal input. The core circuit and associated codes are non-locally distributed within dendritic fields as subsystems of specific brain regions such as the thalmus or the hippocampus. The sequences outside the core circuit model patterns of stored information which is broadcast (or played) into the surrounding neural structures where competitive enhancement is occurring. Thoughts occur when the surrounding neural structures reach a temporal invariance for some short period of time.

$$dx_1/dt = [(d_0(x_2) + d_0(x_1)d_1(x_2)]\, d_0(x_3) + d_0(x_1)\, d_1(x_2)\, [\, d_2(x_3) + d_2(x_3)] - x_1 \qquad (1)$$

$$\begin{aligned} dx_2/dt = {} & d_0(x_1)\, d_1(x_2)\, d_0(x_3) + \\ & [\, d_1(x_1)d_0(x_2) + d_0(x_1)d_1(x_2)]\, [d_1(x_3) + d_2(x_3)] - x_2 \end{aligned} \qquad (2)$$

$$\begin{aligned} dx_3/dt = {} & d_1(x_1)\, d_0(x_3) + \{\, d_1(x_1)\, d_0(x_2) + [\, d_0(x_1)+2\, d_1(x_1)\,]\, d_1(x_2)\, \}\, d_1(x_3) + \\ & [2\, d_1(x_1)\, d_0(x_2) + 2\, d_0(x_1)\, d_1(x_2)\,]\, d_2(x_3) - x_3 \end{aligned} \qquad (3)$$

The dynamics of equations 1-3 forms a transient state homology with the state transition diagram (see Figure 1b). The d functions are indicator functions (Ref 5) constructed from the rule $f(x)=(2x)^n/[1+(2x)^n]$. $d_0(x)=1-f(x)$; $d_1(x)=1-f(x-1)$, and $d_2(x)=1-f(x-2)$. The inclusion of the concept of a switching interval (Ref 4) produces the continuous system which will always exhibit the correct sequences of transient states.

In conjunction with work in progress a threshold value λ_0 for the state 000 is set for the decay equation, $d\lambda/dt = -a\lambda(t) + I(t)$. The coefficient a is a scalar and I is an impulse input from sensory loci or some other internal source. In the model being developed we have the rule: if $\lambda < \lambda_0$ and the system state is 000 then the system remains at 000, if $\lambda_0 < \lambda$ then the system evolves toward the transient state 110.

The core circuit (Figure 1a) does not have an internal connection to the other 8 states of the system (Figure 1b). This connection occurs by an external impulse to the second variable x_2, switching x_2 from 0 to 1 at some time t_s. The key feature of this externally regulated switching is that the sequence of states initiated by the impulse to x_2 depends on the value of t_s in a periodic fashion. Thus inputs to x_2 choose a particular code stored in the "branches" of the network. The dynamics of the system then progress through that branch and play the stored code into surrounding regions of the brain before returning the system to the state 000.

The transition state diagram in Figure 1b is only a prototype of a model of ensemble selection. Naturally a much larger system must account for the formation of an actual concept. However, consistent with the holonomic theory of Karl Pribram we may hypothesize discrete structures, as formal models of the post-synaptic mechanisms (Ref 3) which are thought responsible for the establishment of feature detectors but which are locally a (modifiable) finite-state machine. Collections of such discrete structures are inhibited (or excited) by the state of processes (exchanges of information) occurring non-locally across large sub-regions of the brain.

Acknowledgement: The author wishes to thank Professors Jerome Eisenfeld and Daniel Levine for their helpful discussions. The nature of the indicator functions and the development of a theoretical basis for discrete formalism is part of the author's dissertation and is being written under their direction. A research paper (Ref 5) on discrete formalism and modeling theory is in progress.

References:

1.Bienenstock, E.. Dynamics of the Central Nervous System, in Dynamics of Macrosystems (Lecture Notes in Economics and Math. Systems vol. 257), Springer, 1984.

2. Carpenter, G. A. and Grossberg, S. A massively parallel architecture for a self-organizing neura pattern recognition machine. Computer Vision, Graph., and Image Proc. 37: 54-115, 1987b.

3. Edelman, G. Neural Darwinism. New York: Basic Books, 1987.

4. Eisenfeld, J. and Prueitt, P.S. Systematic Approach to Modeling Immune Response, to appear ir Proc. Santa Fe Institute on Theoretical Immunology (A. Perelson, ed.) Addison-Wesley, 1988.

5. Eisenfeld, J. and Prueitt, P.S. Work in progress, University of Texas at Arlington, 1988.

6. Gelfand, A.E. and Walker, C.C. Ensemble Modeling, Marcel Dekker, Inc, 1984.

7. Grossberg, S. and Levine, D. S. Some developmental and attentional biases in the contrast enhancement and short term memory of recurrent neural networks, J. Theret. Biol.53:341-380, 1975.

8. Hebb, D.O. The Organization of Behavior Wiley, New York, 1949.

9. McCulloch, W.S. and Pitts, W. Embodiments of Mind, MIT Press, Cambridge, Mass, 1965.

10. Minski, M. and Papert, S. Perceptrons: An Introduction to Computational Geometry, MIT Press, Cambridge, Mass, 1969.

11. Rosenblatt, F. Principles of Neurodynamics. Spartan Books, Washington, 1962.

12. Pribram, K. A Holonomic Brain Theory, Cooperativity and Reciprocity in Processing the Configural and Cognitive Aspects of Perception, Manuscript to be published, from Stanford University.

13. Thomas, R. Kinetic Logic a Boolean Approach to the Analysis of Complex Regulatory Systems (Lecture Notes Biomath., 29). Springer-Verlag, New York, 1979.

CARTT: Computer Assisted Remote Television Teaching

Arthur Shapiro*

ABSTRACT

CARTT (Computer Assisted Remote Television Teaching) is a videotape based system designed specifically for interactive distance learning. While it has essentially all the advantages of a satellite transmission system, it may be installed and operated at a significantly lower cost. The system is currently being used to present two college level laboratory projects involving i) a scanning electon microscope and ii) a heart measurement system to secondary school science students while they are in their own laboratories twenty miles away.

INTRODUCTION

Distance Learning, instruction that originates at a point distant from the location of the student with an interactive audio and/or visual component, has been emerging over the last few years as a viable alternative to traditional forms of instruction. The major reason for the growing use of the various systems for distance learning now available is obvious. Cost. There are many situations in which it becomes unacceptably costly to provide a constituency with the necessary instructional materials in a way that is consistent with current standards of educational delivery.

For example, students in the remote parts of our country, such as parts of the southwest, are deprived of the same opportunities available to students in the large cities of those same areas. A secondary school student in Dallas, for example, is offered the opportunity to study latin or german while her fellow student in a small town fifty miles away has no foreign language options; she studies spanish.

A second area where distance learning may have dramatic benefits is in continuing medical education. While a great deal of medical information is conveyed to physicians via the printed page, there are instances, such as the development of new surgical techniques and the proper use of new, complex pieces of diagnostic equipment, when a live demonstration during which the doctors may ask questions is a far more effective method of communication.

While there are many other areas where distance learning may be applied, military training systems, private industry and public institution training programs, and third world educational systems to name just a few, we need not go into them here in any detail. I think it is quite clear that distance learning has a vital role to play in today's world.

THE CARTT SYSTEM

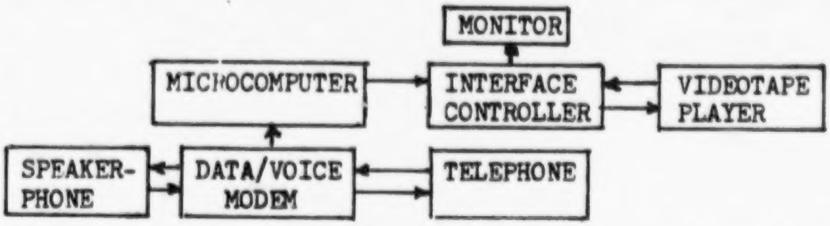
Of all the various types of distant learning systems available today, we will discuss the one- way video, two-way audio group. In all such cases, the video and associated audio is transmitted to the audience via satellite, line-of-sight microwave, or cable; the return audio is effected via a conference telephone hook-up.

---

*Stevens Institute of Technology, Hoboken, New Jersey, USA

While these systems are usually the most effective means for implementing distance learning programs, they are also the most costly. The CARTT System offers essentially the same effectiveness at a fraction of the cost of comparable systems.

A diagram of the basic remote unit of the CARTT System is shown below. The base or "home" unit is exactly the same as the remote unit except for the addition of a digitizing graphics tablet.



The CARTT System operates in the following way. A pre-recorded videotape of the talk is sent to each remote site several days before it is to be shown. Shortly before the lecture is scheduled to begin, a conference call is made connecting the base location with all of the remote locations. At the same time, one person at each site turns on the power to the unit and puts the tape into the videotape player. At the appointed time, the speaker who made the tape, and who is located at the home site, presses a button which remotely starts all the tape players at the same time. In that way, the participants at the various locations are all looking at the same portion of the tape simultaneously. The lecturer is also looking at the tape. If a member of the audience has a question or comment, all he or she has to do is open a microphone and talk to the speaker via the telephone connection. The participants at all the remote sites will also hear the question. At that point, the speaker may either put all the tape players on pause or stop them completely.

There are a number of options the speaker then has. She may simply respond verbally. She may quickly advance or rewind all the tapes to a pertinent section. If the question or comment requires a written response, she can use the graphics tablet to write an equation, draw sketches, or use expressions with symbols. At that point, the videotape image will disappear from all the monitors and the written material will replace it. When the question or comment has been satisfactorily responded to, the lecturer presses a button restarting all the tapes. The session proceeds in that fashion until its conclusion.

Under development at the moment are several enhancements to the system. Briefly, they include:

1. Image annotation
2. Student feedback
3. Storyboards

The first enhancement is the incorporation of an image capture board in the system. This will allow the speaker to freeze a frame of the tape on all the monitors and then annotate the image using the graphics tablet. A second enhancement will incorporate the use of keypads. Up to 128 keypads, each with a unique address, will link to the computer at each remote site providing instant feedback to the instructor. Finally, we are working on the design and coding of software which would allow the speaker to run storyboard programs during the session and have the output appear on the remote monitors.

Our next major step will be the exploration of using videodisk players instead of tape. Although they are more expensive than tape, disks are easier to program so that complex paths through the material may be taken easily. Also, they allow for a greater degree of interaction and they access information almost instantaneously.

Although the individual components of this system are off-the-shelf items, the interface controller and the software were developed specifically for this project. A patent covering the design, the components, and the planned extensions has been applied for.

SCIENCE PROJECTS FOR SECONDARY SCHOOLS

Six months ago, in June 1987, the New Jersey Department of Higher Education agreed to fund a project that Dr. Milton Ohring, also at Stevens Institute of Technology, and I proposed. The thrust of the project is contained in a section of the abstract we submitted with the proposal.

> We are proposing to use a new concept in remote teaching to provide high school students with laboratory experiences which will heighten their awareness of advanced scientific equipment and possibly improve the likelihood of their choosing science as a career. The project will be carried out using two high schools and two experimental modules, one in physics and the other in biology.

The topic we chose in physics is "Fingerprinting Atoms by X-ray Fluoresence." Since the development of this topic will use a scanning electron microscope (SEM), the first segment is a videotape describing its underlying principles. It includes:

1. A model of the atom surrounded by the various shells of electrons.
2. A description of electron transitions between levels caused by the excitation with gamma rays from the electron beam in the SEM.
3. The arrangement of the periodic table according to the resulting x-ray spectra of the elements.

The second segment shows the x-ray spectrometer collecting data and displaying sample spectra. Attention then shifts to the secondary school where students are asked to identify elements using shown spectra and tables provided to them before the session. Finally, an interactive question/answer period takes place to test the students and evaluate their progress and their performance.

The biology project makes available to the high school students material that is unique and unavailable by any other means. It explores some of the factors that affect the function of the heart; how it acts as a pump and how chemical, physical, and electrical influences can change its pumping action. To do this, we rely on the Isolated Working Rat Heart Facility which was built by Dr. Donald DeWitt, also at Stevens, for the purpose of exploring factors that can reduce damage to the heart during surgical repair of the heart.

Once the rat's heart has been surgically removed and put into the Facility, it is possible to measure some of its physical characteristics. For example, Cardiac Output may be determined by combining the collected Coronary and Aortic flows of blood from the heart over a period of a minute. Thus, with the determination of Heart Rate and Cardiac Output, Stroke Volume may be calculated.

Finally, the following experiments are displayed via videotape and discussed interactively:

1. The effect of temperature on the heart.
2. The demonstration of how the amount of blood entering the heart affects Stroke Volume.
3. The effect of epinephrine on the heart.
4. The effect of potassium on the heart.

CONCLUSION

We are in the final phases of evaluating the effectiveness of the program relative to its stated goals. Preliminary results indicate a widening of the program involving a larger number of modules and a geographically wider selection of secondary schools.

DISTANCE EDUCATION - PLANNING AND PRACTICE

D. C. Holznagel*

ABSTRACT

The growing availability of satellite-delivered courses for secondary schools has stimulated great interest in distance education on the part of small rural school districts in the northwestern United States. Such districts are frequently unable to provide opportunities for students in advanced and special subjects comparable to those available in larger schools. The Northwest Regional Educational Laboratory (NWREL) assists those districts in carrying out an appropriate planning process, including examination of technology and nontechnology options. The process emphasizes curriculum and instructional design, and seeks to incorporate video, computer and other technologies where appropriate in an instructional plan. The planning process and issues are discussed, and examples are given of a number of projects using different approaches to satisfying instructional needs in the rural setting.

CURRENT STATUS AND NEEDS

The NWREL is one of nine regional laboratories funded by the United States Department of Education to provide a range of consulting and technical assistance services in evaluation, technology, instructional improvement and other areas to state education departments and school districts. The NWREL serves the states of Alaska, Hawaii, Idaho, Montana, Oregon, Washington and the Pacific Trust Territories and island nations. A special federal grant for rural education improvement supports technical assistance in distance education for small rural secondary schools.

Although the states vary greatly in geography, each has a significant rural population and a large number of small school districts which are remote from population centers and from each other. Staffing problems are common to all such districts. The total staff size is necessarily limited, and it is often difficult to find the individual teachers having sufficient expertise in enough subjects such that a complete curriculum can be offered by a group of five or six teachers. The problem is particularly acute in foreign languages, and advanced science and mathematics. It is also difficult to enlist secondary teachers who are competent in a particular subject to take a job in a rural setting or to teach a broad range of subjects, or both. Thus, capable students may not find all of the instructional opportunities they need to move directly from high school to the college or university curriculum they desire and are capable of handling. Small school districts are very interested in distance education methods which can help them with those problems, and there are many options available to them.

Correspondence courses are the traditional method of supplementing the curriculum for students in remote locations. Each of the states has some mechanism for offering such courses, which are aimed at serving an

---

*Technology Program, Northwest Regional Educational Laboratory, 101 S.W. Main, Suite 500, Portland, OR 97204, USA.

individual student who is homebound or not close enough to a school. Some universities in the U.S. such as the University of Wisconsin offer a broad correspondence curriculum through their extension services. An example will be given later in this paper of a school which makes this option available to students in an organized fashion.

There are several options available in the region for enhancing the school curriculum through the use of technology. The STEP Project (Satellite Telecommunications Educational Programming) is a cooperative of eighteen school districts organized by Education Service District 101, a regional service center in the state of Washington. The subjects are determined and the courses planned by the cooperative. The production and satellite transmission are done at the Eastern Washington University. The production is jointly funded by the districts, and each district acquires its own satellite antenna and receiving equipment. Instruction is one-way video, with two-way audio interaction by telephone. Courses in Japanese, Spanish, Advanced English and Pre-calculus are currently offered.

The Oklahoma State University offers Physics, German, Calculus and Trigonometry by satellite supplemented by telephone in a manner similar to STEP above. In this case, the German instruction includes computer-based student activities with speech generation and recognition.

TI-IN, Inc. is a private, Texas-based company which produces and delivers secondary courses by satellite and telephone as in the above examples. Teacher selection and curriculum development are done in conjunction with state and regional education agencies in Texas. Their subject offerings are extensive, including four foreign languages, five advanced mathematics courses, computer science and several others.

The Utah State Department of Education in partnership with IBM has developed a Spanish course which uses television presentations and computer-based activities, including speech generation for pronunciation practice. The video portion of the course was initially broadcast by satellite, but is now distributed on videotape. The course is marketed by IBM.

The Corporation for Public Broadcasting is developing courses which include printed student materials and videotape. There are also occasional satellite transmissions of programs by the National Aeronautics and Space Administration and others which can be used to enrich existing courses. In addition to those for secondary students, courses and programs for the inservice training for teachers are offered by the STEP, OSU, and TI-IN organizations. These use the television presentation and telephone discussion format, but do not use computer activities.

All of the services mentioned here are available over the entire U.S., and hence to all the states in the northwest region. Their availability is widely known, and many school districts are examining the programs and the implications of their use. However, not many schools in the region are using the courses yet. The most used are those from STEP, but the project has been in operation only two years and is only beginning to expand outside of Washington. A major roadblock to increased use is the high cost of programs and equipment. For example, the costs for STEP are an initial charge of $8,500, which includes receiving site equipment, plus a recurring per course fee of $600 to about $4,500 depending on the number of students enrolled. Costs for the other options are similar. We can expect the cost of hardware to fall, and the course cost per school could be reduced somewhat. Furthermore, the cost of the video/audio courses is far less, and the certainty of obtaining them far greater, than that of a teacher. Nevertheless, the rural districts are frequently not wealthy, and the advanced courses desired will be attended by a relatively small number of students, so the cost per student is prohibitive for many.

Still, the interest is so high that we find many districts moving quickly to obtain equipment and courses. Our major concern is that they are often not carrying out a thorough planning process and, in particular, are not examining the implications of such decisions in terms of staff, facilities, accreditation and evaluation.

PLANNING ISSUES AND OBSERVATIONS

Technology brings opportunity, but also the need to be more thorough in planning and preparation, because the learning environment is different from the traditional, and the potential for underachievement by students is high. Even though some of the technologies for distance education are relatively new and their development is rapidly increasing, experience in distance education, curriculum design, and the conditions for a good learning environment is not new. Many principles for guiding the planning, implementation and evaluation of technology-based distance education can be deduced from that knowledge base. The NWREL has produced a report which is a synthesis of the existing research and writing, and displays the issues, considerations and principles for successful projects as sets of guidelines (ref 1). The guidelines are useful in our assistance program for schools.

The technical assistance program of NWREL for small, rural schools can provide expertise in any phase of a distance education project, although in practice it has focused on planning and evaluation. We are developing and testing the service with five pilot sites, which are individual or small groups of districts having an interest in enhancing their curriculum. The NWREL staff work with small committees of district staff to analyze needs and facilities, identify and evaluate options, develop cost analyses, and assist in plan development. NWREL maintains access to databases and other information sources about computer software, video programming and other relevant data which a local district ordinarily does not. Some of the issues districts consider in the planning process are:

Careful needs definition
Costs
Cost effectiveness
Funding
Teacher Certification
Accreditation
Curriculum Development
Management
Scheduling (Timetable)
Student Support
Evaluation
Organizational Change

The NWREL assistance in the evaluation of projects is directed at both projects and students. Because we are in the first year of such assistance, not much conclusive data is yet available. However, because some of the pilot projects have been ongoing for a year, some information about the relative success of various approaches to implementing distance education should be available in the Fall of 1988. We are particularly interested in identifying aspects of planning that are crucial to student success.

In our interviews to date with teachers, aides and administrators, one major area of common interest has been identified. In all of the schools, there is a staff person selected to monitor or coordinate the group of students participating in the distance course. The person is sometimes a certified teacher (not necessarily of the same subject), but more often an aide (frequently without teaching background). All interviewees describe the role of this coordinator as a key to student and project success. However, the role definitions and expectations for such a job vary from school to school, even with schools using the same course. A general assumption is that the role is limited, and the position will be filled at far less expense than for a teacher. Yet virtually all have identified teacher-like characteristics which are important. A job definition and training requirements should emerge during this year.

PROJECT EXAMPLES

The following list is not exhaustive of the projects in the northwest region which are attempting to use technology to advantage in distance education. It is intended to show that a variety of technologies are being tried, and provide a broad sample of the effects in the region.

Anchorage Career Center, Anchorage Alaska - uses audioconferencing to conduct student discussions with sister school in Japan.

Idaho Rural Education Delivery System - uses public television stations and a PLATO computer system to deliver a math course.

Lewis County, Washington - uses microcomputers and slow-scan television to deliver a technology course.

Jefferson High School, Oregon - uses electronic mail system in a Fiction Writing course.

Distance Learning in Small Schools, Alberta, Canada - uses facsimile machines for transmitting student work in correspondence courses.

1. A, Batey and R.N, Cowell, Distance Education: An Overview (Northwest Regional Educational Laboratory, Portland, OR, 1986)

TELEVISION: OLD TECHNOLOGIES AND NEW OPPORTUNITIES

R. Daniel Norman*

ABSTRACT

Instructional television has for three decades sought to impact and support the traditional learning environment. Generally, its successes were not as originally envisioned. Regional public broadcast stations were confronted with a multitude of varying regional classroom schedules and differing curricula. Always skeptical regarding the potential role of educational television, teachers generally found it easier to adopt an unacknowledged policy of benign neglect rather than wrestle the more difficult problems of program integration with curricula content or solve the ever-present scheduling and logistical problems. New strategies, which serve to link older technologies, may provide school districts with new resources in meeting educational objectives

INTRODUCTION

While the video cassette has revitalized interest in instructional support programming, it is but one component among many which offer new opportunities for broadcast systems to play expanded roles in meeting a range of community education needs. Two distinct differences will characterize school district and regional cooperative broadcast systems from traditional early regional educational television systems. First, the systems will be characterized by their integrated strategies in combining components such as regional microwave links, satellite reception and distribution, Instructional Television Fixed Services (ITFS), or defused microwave systems), open broadcast, cable delivery, and some interactive method for instructional programming. While both interactive video and audio are possible, local school districts may more frequently be characterized by the use of interactive audio only since this is generally cost effective by use of telephone lines. Also feasible with the telephone line is facsimile transmission. Teaching support materials, tests, and other communications can be easily and inexpensively transferred to multiple distant locations. Student work and tests may be returned to teachers by the same method. Facsimile transmitters may be linked with computers which automatically maintain mailing lists, coordinate transmissions, and schedule them, if desired, for the "low cost" transmission times.

The second characteristic is closely related to and helps explain the first characteristic. This is the fact that community needs and potential audiences for these broadcast services will be identifiable and specific rather than broad-based and general. Indeed, the relationship between these two characteristics of school district broadcast services is something akin to the old "chicken and egg" quandary. The components of new broadcast strategies will permit a school district to speak to an individual class at home or a continent way. That same system may deliver education services to a single corporate client or reach every community home. Local school district networks for television services are providing and will continue to provide new educational markets through targeting specific audiences by means of interlocking multiple broadcast strategies.

Henrico County Schools, a large suburban school district surrounding Richmond, Virginia, is in the process of developing a broadcast system based upon these characteristics. In 1984, Henrico began an effort to develop a comprehensive broadcast system which would link microwave, public broadcast, ITFS, cable broadcast system which would link microwave, public broadcast, ITFS, cable distribution, and eventually satellite transmission strategies. Again, the second key element in this planning was the belief that education, corporate, and community audiences for these services would represent needs that tended to be focused and specific rather than general.

---

*Assistant Superintendent, Henrico County Public Schools, Richmond, Virginia

DISTANCE LEARNING/DIRECT INSTRUCTION

The first phase of the development was a partnership between Henrico Schools and the Virginia State Department of Education. The State provided funding as part of a project on Innovation and Technology sponsored at one of the Henrico high schools. Since 1984, Henrico has been delivering high school course instruction from a central electronic broadcast classroom. Currently, daily classes enrolling local students in Latin I, Latin II, Advanced Placement Calculus, and Advanced Placement English are microwaved to the regional public television station and from there are transmitted by public broadcast throughout central Virginia. Approximately 400 students at 35 satellite sites are enrolled in the classes. Combinations of satellite and microwave transmission may eventually replace the open broadcast segment. Students are linked back to the teacher by telephone which permits immediate two-way audio communications while the class is in progress.

One of the continuing instructional concerns in support communication may be relieved by facsimile transmission. Linked to a computer coordinating programs, this can provide immediate transmission of student tests, paper documents, and resource materials which need to move quickly between the teacher and students in the satellite schools.

Although the electronic classroom does not portend a rivalry for the traditional classroom, it does provide a solution for students in schools where certain advanced subjects may not be available for reasons of limited enrollment or the lack of qualified teachers in certain subject areas. The eventual replacement of the public broadcast of the classes by use of satellite transmission will increase the number of students who may receive instruction from a single classroom teacher and consequently will alter the delivery services model. For example, as the pupil/teacher ratio increases by expanded broadcast technology, support personnel such as graders or teacher aides will be required for a proper system of student assessment and evaluation within the classes.

An important linkage for the district will be its capacity for two-way video and two-way audio communications with three major universities in Virginia via microwave. With the district's distribution of programming through an ITFS application, higher education and public schools may develop partnerships not previously feasible. University instruction in the secondary school for gifted students and staff development activities will be but two areas of opportunity.

ITFS PROGRAM APPLICATION

The second major component in the Henrico broadcast strategy will be the use of a diffused microwave broadcast from a central studio to each of the county's fifty schools. The ITFS studio center is being constructed as a part of a new school administration complex. Since public rights to the remaining ITFS systems have been assigned to regional public television stations, Henrico schools has entered into a contractual arrangement with the regional public broadcast corporation. Transmission will be sent by microwave from the central studio to the station and retransmitted to all schools from that site.

It is important to note that the intended program uses for this component of the system do not parallel the traditional educational objectives associated with early open broadcast efforts. Henrico schools is committed to use the resource for specific target audiences and multiple but limited program objectives. Four areas of intended use appear particularly appropriate for ITFS. First, programming which provides specific support to classroom teachers, which is not otherwise available, will be used. The system will not broadcast general curricula or commercial programming which is available via public broadcast or video cassette. The system will broadcast, with two-way audio interaction, support elements otherwise not available. One example of this application is found in the school system's foreign language program. Henrico provides a foreign language program beginning in kindergarten. The program relies on regular elementary teachers using video tapes written and produced in the system. Approximately 500 teachers, many with little or no foreign language proficiency, provide instruction using pretaped sequences. Non-language teachers are the only reasonable option for carrying forward the core of the program since qualified language teachers will not likely be available in numbers sufficient for such programs. Although the curriculum tapes are proving to be very effective, there is a clear need for additional spontaneous interaction with students and verbally fluent models. ITFS broadcast could specifically support the curricula by bringing language fluent teachers into the classroom for spontaneous interactive communications with the children. In many other curriculum areas ITFS may be able to deliver into any classroom, at any time, prominent guest lecturers and teachers, and serve as a delivery system for satellite programming or predeveloped modules such as laboratory experiments. The key to success in making ITFS a vital support resource for classroom teachers will be to match real need with focused programming. If that occurs, general information programming will have only a minor role in the ITFS strategy.

A second ITFS program priority will relate to the development of a corporate market for direct educational and training services. Most urban/suburban school systems provide extensive adult and community education services. These services have traditionally been directed at individuals seeking personal growth or improved career skills. Generally overlooked in this effort has been local business, industry, or services corporations which face demanding needs to adapt its work force to new jobs or markets requiring new employee skills or an expanded general education background. These same employees often are the first receivers of school dropouts. Within a community, ITFS offers a way to develop education and business partnerships aimed at assisting corporations with specific training needs. The same antennas that go on a school can, by properly designed partnerships, go on business and industry roofs. Interactive broadcast instruction can be delivered directly to the work station. Without the artificial restrictions of credits and accreditation; classes, seminars, and training opportunities could be custom made and remain cost effective for the business partnership. The priority for these services is related to the individual needs of the business for training, not programs for personal improvement such as the GED. Personal and individual education needs may be served additionally by cable strategies.

The third priority for ITFS programming is the obvious opportunity it presents for staff development and training. Large school districts are naturally scattered over expansive geographic areas. ITFS provides the method by which employees at these sites may be linked for training. In the same way that ITFS may serve business, it may also distribute staff development programs to other schools or districts, particularly small rural districts, by the same partnership arrangements envisioned with the private sector. Also important is the availability of programming services for other county agencies with training and communication needs. ITFS could easily link firehouses and police precincts in common programming and training needs.

The fourth and last ITFS priority in Henrico relates to system-wide employee communications. Programming which explains, informs, and provides a forum for interactive personnel communications is needed. Whether the task is explaining a new hospitalization program to 4,000 employees at 55 sites or simply sharing news of the organization to improve morale, ITFS will be a significant step in organizational communications. If ITFS is perceived merely as some sort of closed-circuit institutional TV system with general programming, its real effectiveness is probably minimal. If it is perceived as one link of a larger interconnected and interactive broadcast strategy, its "focused" role can be vital.

COMMUNITY NEEDS/CABLE

The third ingredient in the Henrico broadcast system did not require additional technology; it simply proposed a closer working partnership with the local cable company. Although this avenue has been available for some time, the lack of school system production facilities prevented any real use of the resource. The linking of the school system's broadcast facilities and local cable access will enable the school system to pursue a separate but significant set of programming priorities from those listed with ITFS or distance learning. These priorities include new program initiatives in adult education (particularly support information programs for senior citizens), literacy needs, parent and parenting education, and finally community involvement programming.

Appropriate cable programming can meet educational needs when ITFS is not accessible and open broadcast is not feasible. Well-developed partnerships with cable companies must be realistic. They must reflect and respect the entrepreneurial purposes of the company while demonstrating that quality educational programming can be balanced with specific as well as general audiences so as to be cost effective. Strong models for such partnerships already exist, including the supportive reception given in Henrico to its initial efforts.

VOCATIONAL EDUCATION: TELECOMMUNICATIONS

The final element in the Henrico broadcast system is more related to production than delivery strategies. The school system has proposed as its final component in its broadcast strategy the construction of a Vocational Telecommunications Center at one of the district's vocational-technical schools. Reflecting the dramatic growth in career opportunities in the field, the vocational program would provide cost-effective student employment in the system's operation as well as obvious training opportunities. Although traditionally associated with "television employment," in reality the market for video-graphics, technicians, writers, editors, and others has extended to employment in advertising, marketing, education, and the internal production departments of many large corporations. This facility will provide the final linkage for student-produced programs and community broadcast services.

SUMMARY

The basic objective of this local school district effort is very simple. That objective is to recognize that separate technologies, many not new, now exist in ways which offer school districts new opportunities for being more successful in meeting many long-standing educational goals. A critical element in seizing these opportunities in telecommunications rests in matching the audience for educational services with the most effective delivery strategy; that is a function of clear and focused educational objectives. It will be another wasted resource if the technologists and educators remain mutually exclusive.

PLANNING FOR THE UTILIZATION OF TECHNOLOGY IN SCHOOLS

Salvatore J. Corda*

ABSTRACT

The integration of technology in a school curriculum is effectively accomplished through a process which acknowledges that goals change as new information becomes available and external pressures vary, that the power to influence decisions must be shared among many, and that a variety of activities will be occurring simultaneously. The necessary factors are a willingness to take risks, trust that experimentation is encouraged and supported, and an agreed upon statement of purpose and mission. The success of the effort is predicated on the belief that curriculum drives the use of technology, that technology will facilitate the learning process, and that technology will enhance, not replace, the role of teachers.

The integration of technology into schools is accomplished on two fronts: by those teachers and administrators who are innovators and experimenters in an unplanned, *ad hoc* fashion and by the development and implementation of a comprehensive plan which provides an orderly process of implementation and which monitors the pro- gress which has been made towards reaching specific goals and objectives. While planning alone cannot produce the entrepreneurial spirit of a small group of staff who will experiment with technology, the systematic use of technology can only be accomplished after care-ful thought and planning. It is this planning which will foster an atmosphere of innovation and will, ultimately, move an educational system to use technology in as broad a way as possible.

PLANNING FOR TECHNOLOGICAL CHANGE

Although technology has not yet become as commonplace in schools as chalkboards, the day is rapidly approaching when the presence of technology equipment in classrooms and in other school facilities will become commonplace. The question which we as educators must answer is how do we make intelligent decisions about planning for the future when we are still learning about how technology can be used effectively and when we realize that schools function in an environment which is no more rational than any other organization?

I believe that the answer lies in using a process which will allow for both a systematic and a serendipitious utilization of technology. The implementation process, to be effective, must be broad based in its involvement of staff. It must also be flexible enough to accommodate new external pressures as they emerge and to allow for the continual infusion of technological advances into the curriculum. Finally, the process must provide a clear sense of direction as to where the district is going with respect to using technology.

---

*Salvatore J. Corda is the Associate Superintendent of Schools of the Greenburgh Central School District, Hartsdale, New York, U.S.A.

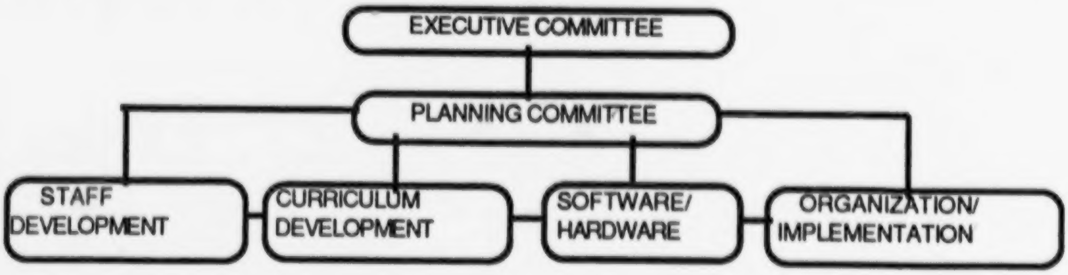
I believe that the answer lies in using a process which will allow for both a systematic and a serendipitious utilization of technology. The implementation process, to be effective, must be broad based in its involvement of staff. It must also be flexible enough to accommodate new external pressures as they emerge and to allow for the continual infusion of technological advances into the curriculum. Finally, the process must provide a clear sense of direction as to where the district is going with respect to using technology.

Patterson, *et al.*, (ref 1) have made a strong case for looking at schools as nonrational organizations, *i.e.*, as entities operating in a larger environment which is not always logical and predictable. The devel-opment in a school district of a Technology Applications Plan takes this into account as it provides a blueprint which the district will follow in infusing technology into the educational program.

The Technology Applications Plan model was developed at the Merrimac Education Center in Chelmsford, Mass. under the leadership of Richard Lavin and Charles Mojkowski. The model was refined for use in New York State by the Center for Learning Technologies, directed by Gregory M. Benson. The training sessions for local school districts in using this model were coordinated by Ronald Sczypkowski, President, of Magi Educational Services.

TECHNOLOGY APPLICATIONS PLANNING (TAP)

TAP uses a model which involves a broad base of staff from a member of the Board of Education, central administration staff including the Superintendent of Schools, building administration, computer specialists and teachers from every grade level, curricular area, and special interest, *e.g.*, students with special educational needs. Structurally, the participants are arranged in the following configuration:



This arrangement does not suggest an hierarchical relationship. It does illustrate the relationship among the various sub-groups to the Planning Committee and to each other. Focus must be on these components if the infusion of technology into curricula is to be comprehensive and meaningful.

THE EXECUTIVE COMMITTEE

The purpose of the Executive Committee is to serve as a planning body in the preparation of the agenda for Planning Committee meetings and to provide leadership and guidance to the Planning Com-mittee in its deliberations. The Executive Committee is the Planning Committee's link to the larger community environment in which the school district exists. In our district, this committee is composed of the Superintendent of Schools, a member of the Board of Education, and the Associate Superintendent of Schools who has responsibility for the development and

---

1. J. L. Pattersoon, S. C. Purkey, and J. V. Parker, Productive School Systems for a Nonrational World, (Association for Supervision and Curriculum Development: Alexandria, Va., 1986)

implementation of the district's technology program.

THE PLANNING COMMITTEE

The success or failure of a comprehensive integration of technology into curricula depends to a very large extent on the committment and the work of the Planning Committee. In order to be effective, this committee must discuss and think very seriously about the purpose of education, the changing nature of the student as learner, and the values of the community. From these deliberations, the committee will form its own vision of the future of the school district. This vision is developed into a formal statement of the philosophy, mission, and goals of the school district. Because the planning committee is composed of a broad representation of staff members, who should be in communication about these issues with the rest of the District's staff, the philosophy statement is realistically the consensual committment to the future direction of the district.

The Planning Committee meets on a monthly basis to discuss the progress of the various subcommittees; to consider emerging issues of district-wide importance; to provide support for unanticipated efforts which will further the integration of technology in the learning process; to monitor the implementation of the Technology Applications Plan, and to collaboratively develop the annual revision of the plan.

THE SUB-COMMITTEES

Each of the four sub-committees is composed of one or more of the Planning Committee members and a broad spectrum of staff members who are representative of all grade levels and curricular areas. Each of the sub-committees is responsible for preparing a part of the overall plan which includes the following components: present status; desired status, competencies, or requirements; needed resources, and the action steps which will be taken to meet the particular goals for that year. In addition, the sub-committees will identify and develop support for innovative opportunities which have developed in addi- tion to the particular goals which have been identified for the year. The size of the sub-committees is arbitrary: large enough to provide broad representation of staff, yet small enough to be effective.

The activity level of the sub-committees will vary depending on the particular needs to be addressed. For example, preparation for a technology staff development day occupied a great deal of time for that committee until the day was concluded. This activity also clearly demonstrated the interdependence of all of the sub-committees since the curriculum committee worked very closely with this group to assist in the identification of needs and suggested activities to meet curricular needs. Similarly, a proposed bond issue to provide major financing for significant equipment purchases required the efforts of all of the sub-committees to persuade the community that the expenditures would be educationally and fiscally sound.

CONCLUSION

Technology as a force in reshaping schools will be measured by its ability to provide new opportunities for learning those process, learning, thinking, and reasoning skills which are necessary for students to become lifelong learners. Unless it serves this purpose, it will not, and should not, be used in significant ways in schools.

The value of the Technology Applications Planning process is that it requires the efforts of all of the significant factions of the school community in the development of a plan which will guide the district in its efforts. The plan, therefore, is the work of many who have a vested interest in its success. The TAP process is flexible enough to change as required while keeping its eye on the philosophical assumptions which have generated the plan. The process also pro-vides the means to support those unanticipated, innovative oppor-tunities which can mean the difference between success and failure by giving to those efforts the legitimacy of official endorsement and the necessary resources to support the activity. In other words, TAP *empowers* individuals as well as the organization.

School districts which do not provide a systematic process for program planning and development will find themselves reacting rather that proacting to situations and with fragmented efforts to integrate technology into the curriculum limited by the annual appropriation in the computer budget.

As the ancient proverb says, "Unless we know where we are going, we will arrive where we are headed." TAP provides the opportunity to be the captains of our own ship.

LIBRARIES AND INFORMATION TECHNOLOGIES: TO BE OR NOT TO BE.....

M. D. Boone*, R. W. Collins**

ABSTRACT

Until very recently, it would be unthinkable to have the academic library be anything but a repository of material waiting to be discovered by student and scholar. However, with the explosion of a wide range of information technologies, some libraries are changing. The questions of how, why and where will be covered both in general and specifically with a look at Eastern Michigan University's developmental approach to transforming a traditional library into an information utility.

INTRODUCTION

Historically, academic libraries have been responsive to student and faculty needs rather than proactive. The relatively new introduction of "converging information technologies" has brought to our attention a serious crisis of purpose concerning the traditional roles of this support service. In many instances, the administrative responsibility for integrating information technologies into the mainstream of the educational mission is divided among the computer center, media center and the library. As the technologies continue to converge rather than staying distinctly separate, it becomes more obvious to academic decision makers that the separate administration of such technologies may not be as practical as once thought.

The question to be addressed in this paper is what the role of the library might be in this convergence of the administration of information technologies. After a brief review of current literature on this question, the library-centered developmental approach being used at Eastern Michigan University will be described.

BACKGROUND

In his keynote address to EDUCOM-87, John Sculley, President of Apple Computers (ref 1), talked about the changing needs of workers, students, teachers and researchers. He sees the need for a change from giving students specific knowledge to giving them the tools for access to the world of knowledge. As he states, "....which means that our students will not simply be learners, passively absorbing subject matter, but more like researchers actively exploring their environment. To work in research is to recognize that knowledge does not reside privately in individual minds, or textbooks, or journals, or libraries, or laboratories, or databases. Knowledge resides in a complex web that encompasses all of these." Murr and Williams (ref 2) also discuss the need for knowledge users to have vastly improved access to information. They state, "The key questions in access and use of information and knowledge are: Where do I find desired information? and, After I have processed and used it, how do I store it for subsequent use?"

*Dean, Eastern Michigan University, Ypsilanti, MI. 48197, USA.
**Provost, Eastern Michigan University, Ypsilanti, MI. 48197, USA.

On many campuses, the library may not be where the adoption of information technology is being initiated. The more technological sophisticated research institutions are beginning to involve their libraries in convergence that has been initiated elsewhere in the organization. However, at less technologically sophisticated non-research centered universities such as Eastern Michigan University, unless the library becomes a proactive initiator, its traditional services may become out of step in the battle of needs versus scarce funding allocations. That is, if the library is seen as an island of print resources (aided or unaided by computer automation and laser-based storage/retrieval devices), the computer center is seen as being responsible for computer systems and networks, and the media center is seen as the seat of all visual communications, then the cost of supporting such separate information systems (both in terms of benefits and effectiveness) will be too great for most institutions to bear.

Watson, et al (ref 3) provide a look into what some think will be the norm for learners by the year 2000. This vision of the new educational system is a workstation-based system that will allow for all types of direct and indirect learning in public education, higher education, home setting and other social contexts. The workstations will allow for complete integration of voice, video and data transmission of full-text information and pictures with sound in an interactive network mode. The technologies that will allow this to happen are already here and most of them are out of the lab and on the market. However, to bring this vision into being, much work will have to be done on information conversion and integration into better constructed learning systems. Sculley (ref 4) believes that the technological tools needed for solving the learning systems problem will be built on three core technologies: 1) hypermedia, 2) simulation, and 3) artificial intelligence. The former problem, information conversion, is not as much a technological problem, but one which is rooted in societal, political and economic barriers. This is the problem that provides the library, as we know it today, with its greatest challenge for the future. It has been the custodian of the world's information treasures as physical objects; the challenge for it will be in changing to a facilitator of information as a utility.

Like many institutions of higher education, Eastern Michigan University has begun to recognize this challenge. Of course, a few universities have both the mission and sufficient resources to take giant strides in reorganizing to meet the new world of the information utility. But EMU is different from these few special universities and, consequently, must find a slower, less costly way of meeting the challenge. The remainder of this paper will describe how EMU is developing a proactive posture toward changing how it deals with new information and learning technologies.

ORGANIZATIONAL SETTING

Eastern Michigan University (EMU), located in southeastern Michigan, is a comprehensive university with a current enrollment of over 23,000 students (17,000 undergraduates) and a full-time faculty of 680. EMU shares a history much like many state-supported regional institutions that began as teacher training schools. It has grown from a student body of approximately 2,000 in the early sixties, to one with ten times as many students and four colleges, in addition to the College of Education. Today, its mission still includes educating many of the public school teachers in the State of Michigan, but it also has become known for strong programs in applied technology, human services, business and the liberal arts.

The organizational structure for administering the library, media services and computing has been similar to many other non-research oriented universities, the library and media services reporting to the academic side and computing reporting to the administrative side. Beginning as early as 1983, it became clear that the traditional administrative structures governing the information-based educational support services were not optimally responsive to the changes taking place, both internal to the institution and those taking place in information and learning technologies. The Provost decided to reorient the administration of support services under his control that directly impact on the instructional mission. The reoriented structure was implemented in January, 1986 and is fully described in a recent paper by Boone (ref 5).

Figure 1 provides an outline of the new Learning Resources and Technologies (LR&T) organizational structure:

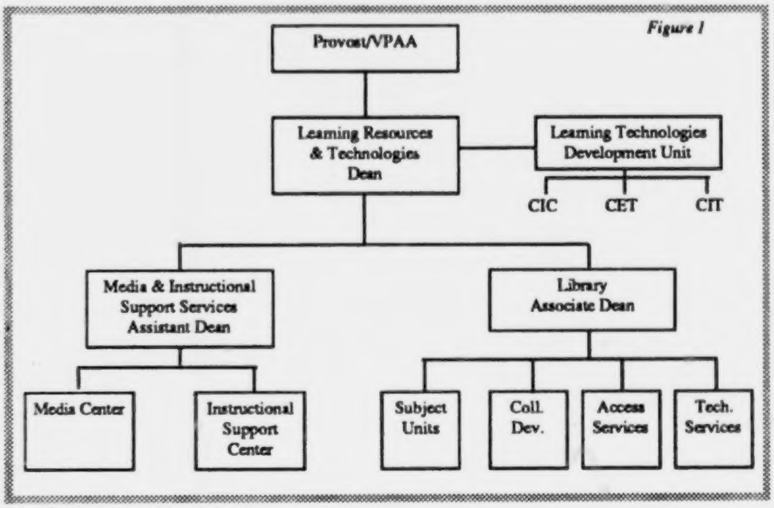


Figure 1
Provost/VPAA
Learning Resources & Technologies Dean
Learning Technologies Development Unit
CIC
CET
CIT
Media & Instructional Support Services Assistant Dean
Library Associate Dean
Media Center
Instructional Support Center
Subject Units
Coll. Dev.
Access Services
Tech. Services

One of the most significant changes directed toward the challenges previously discussed was the creation of the Learning Technologies Development Unit led by the newly named Dean.

LEARNING TECHNOLOGIES DEVELOPMENT UNIT

The Learning Technologies Development Unit (LTD) was formed to provide a structure for the faculty-centered familiarization, assessment, planning, development and application of information and learning technologies as they apply to the instructional mission of the University. Specifically, the technologies involved are: computers as a tool within instruction and learning (CAI, CAL), and within the administration of instruction (CMI); video within instruction and learning (ETV), and as a product itself (telecourses); and electronic information as a tool (bibliographic databases) and as a source (full text). The Unit has three components: - the Center for Instructional Computing (CIC), the Center for Educational Television (CET), and the Center for Information Technology (CIT). All three Centers are staffed by faculty on release time assignment. Each Center has a direct link to at least one existing operational unit. That is, the CIC's activities are related to the Instructional Support Center and the Computing Center; the CET's activities are related to Media Services; and the CIT's activities are related to the Library and the ISC.

The Center for Instructional Computing (the first and only one of the three Centers to be active at this time) had its start as a Provost's initiative in 1983. However, it became fully funded with its own facility within the University Library building in January, 1986. Since then it has served or involved over a third of the full-time faculty in introducing them to microcomputing in general, and to its uses within instruction specifically. Its program is supported by an eight-station PC Lab, five-unit mobile PC/Projection classroom service and an extensive software and print library. It is staffed with two FTE faculty release-time assignments. The most successful programs are: individualized faculty workshops, faculty computing grants program (10 awards per year), newsletters, seminars and consultant services. The CIC and its programs are described in a CAUSE '86 paper by Boone and Ferrett (ref 6).

A new project, the development of an instructional technology assessment model, is beginning in the '88 Winter Semester. It is the initial step in creating a mechanism for faculty to participate in the strategic planning for technology adoption and activation of the other two Centers.

CONCLUSION

If the library as a place where materials repose is to become an information utility providing an interactive service to its clients, then the library cannot be content with embracing information technologies, but it will have to find ways to becoming proactive in its development and adoption by faculty and students. Eastern Michigan University is beginning this transition through the establishment of its Learning Technologies Development Unit. For it, the answer to the question, "To be or not to be?" is "To be!" However, "To be what?" will remain an open question for quite some time.

REFERENCES

1. J. Sculley, EDUCOM Keynote Speech (Draft 10- October 27, 1987), p. 4.
2. L. E. Murr, J. B. Williams, LIBRARY HI TECH, #19 (1987), p. 18.
3. J. A. Watson, S. L. Calvert, R. Collins, ED TECH, (November, 1987), p. 19.
4. J. Sculley, EDUCOM Keynote Speech (Draft 10- October 27, 1987), p. 5.
5. M. D. Boone, CAUSE '87 PROCEEDINGS (1988).
6. M. D. Boone, R. L. Ferrett, CAUSE '86 PROCEEDINGS (1987), pp. 491-498.

DEVELOPING A SCHOOL SYSTEM COMPUTER CURRICULUM

Patricia I. Barrow

ABSTRACT

Development of a district wide computer curriculum involves several components; most importantly direction, commitment, involvement, time and staff development. The first of these, program direction influences many later choices. Commitment to the program and its objectives by the superintendent and school board indicates the importance of the program and encourages involvement for principals and staff. This commitment is often best demonstrated by monetary support. Staff development provides the knowledge necessary to allow the program to proceed as planned. Three levels of training have been developed. All good programs including a computer curriculum require time for planning, implementation, testing, evaluation and revision. Due to the rapidly changing technology this must be an ongoing process.

INTRODUCTION

Guilford County School System is a public school system located in central North Carolina, USA. The 41 schools are grouped in an elementary (K-5), middle (6-8) and high school (9-12) configuration. The student population is about 24,000 students and the instructional computer population is over 1000 units.

DIRECTION

Establishment of the goals and direction of the computer educational program should be the primary step. This step may not necessarily occur before computers are used in any classes due to the experimenters in the system but should follow soon afterwards as formal written goals provide the foundation upon which all further decisions are made. Among the questions that must be answered are these. Are computers to be taught about? (Computer Literacy) Shall they be used to provide a new way to present traditional instruction? (Computer Assisted Instruction) Are students to be taught to program these machines? (Computer Science) Are the unique characteristics of the computer to be used to teach students how to learn? or will the curriculum include all of these facets?

Guilford County School System, Greensboro, N.C. 27401, USA

For Guilford County Schools, the objectives include all phases of computer use. These objectives were developed by a committee of teachers, administrators, parents and outside experts. Generalized system objectives apply at all grade levels K-12 but they include skills, applications, attitudes and knowledge. Students should leave the program with a knowledge of what a computer can and cannot do, understanding of appropriate and ethical computer use, and the ability to operate the computer. All students do not need to be programmers nor computer historians.
From these system objectives and those set forth by the North Carolina Department of Public Instruction grade level curriculum is evolving with specific measurable objectives for each grade level.

Selection of hardware since 1985 has been made on the basis of suitability for the application. Although most instructional computers are the same brand, special purposes require special units. Journalism, drafting and the secondary business program have different hardware needs.

COMMITMENT

Expressed and concrete commitment of the administration to computer education is necessary for an effective program. Verbal support is helpful but most often the financial support of a district says more to the teaching staff and the general public than any words or documents. What occurs in a classroom is determined by the classroom teacher's concept of its importance to the administration and the parents. The North Carolina Legislation committed itself to computer education with a three year funding that provided 1 computer per 50 students. The local school system has provided monies for 8 computer education specialists, software and computer laboratories for each school. The ratio of computers to students in Guilford County is now better than 1 to 25 because of commitment from the administration and local parent and civic groups. The message that computers are an important part of today's world is being received loud and clear.

INVOLVEMENT

The success of any curriculum or educational trend is dependent on the teacher in the classroom. People are more likely to want a program to succeed if they have been involved in planning it and developing the activities and materials to be used. Teachers and specialists from each subject area and each grade level developed teaching techniques, activities and materials to teach the subject concepts using the computer. Classroom teachers were provided with release time or paid to evaluate software for their subject area or grade level. This provided knowledge of the programs for the teacher and resulted in the purchase of programs that would more likely fit the needs of the teacher.

In any group of educators, there are those risk takers that want to try new things. If these risk takers are encouraged to pilot projects using computers more, teachers can be enticed into the world of technology. We have a high school language class working on software for the middle school french class. A chemistry teacher used his computer to measure freezing points of mixtures and is now teaching other teachers in addition to introducing his students to a real world use of computers. A roving art teacher is introducing classes in three schools to computer art. Another has mastered a news program and is teaching others. These teachers have created their own ideas and dreams and this creative process is contagious.

Involvement of subject area supervisors encourages the computer to take its proper place as a teaching tool that can do some of the standard teaching processes such as drill and practice, but also provides a whole new way to handle information. Subject area supervisors must see the uses of computers for students before they can help teachers who do not want to change to explore new methods.

STAFF DEVELOPMENT

Staff development must provide for levels of expertise and levels of interest. The adventurers must be encouraged to experiment with combinations of computers, children and uses to demonstrate to others what technology can add to the educational scene; while those with great fear must be led into acceptance of technology. Provision of workshop training is acceptable with methods of bypassing these workshops if content has been mastered.

Guilford County Schools has implemented three levels of training. Level 1 is required for all personnel: teachers, principals, and supervisors. This would include general operation and care of a computer, what it can and cannot do, how computer use affects society, copyright policy, simple use of a word processor, database and other utilities, software use and evaluation. Level 2 is encouraged for all teachers. The major emphasis is integration of computer use in subject area instruction. Application software, telecommunications, authoring programs, desktop publishing for journalism and yearbook classes, electronic data acquisition for science classes, development of timeliness for social studies and book reviews on disk are current topics. Level 3 is advanced training for teachers with real interest in computers who will serve as lead teachers. It includes trouble shooting, advanced operations with application software, project and curriculum development and use of new technology.

TIME

Development of a computer education curriculum requires time, usually several years. Success without preparation seldom occurs. Preparation requires time; time to determine objectives, to select hardware based on objectives, to provide Level 1 training for all teachers and to allow time for some teachers to get over their fear or distrust of the machine.
After the development of the grade by grade program based on Guilford County objectives and state guidelines, several years will be needed to implement the program. Due to a concurrent change in school structure, our implementation started with middle school. The courses will change over the next three years as students coming into these grades have more experience. The elementary program (K-5) is underway with formal goals for each grade level in the testing stage this spring.

Three phases in the development of our computer program have emerged at this time. Phase 1 includes determination of program direction, selection of appropriate hardware and software, establishment of computer labs and introductory training for teachers. Phase 2 includes the development of grade level curricula including activities, software assignments and measurable objectives. Pilot projects to test the feasibility of programs and ideas before system wide implementation and Level 2 and 3 staff development are included in this phase. Phase 3 will include evaluation and revision and is expected to be a continuous process.

SUMMARY

Development of a satisfactory system-wide computer curriculum requires determination of program goals, commitment from the administration, involvement of the total staff, training for different levels and interest and time. This process is not a one time affair but an evolving activity.

STRATEGIES FOR USING MICROCOMPUTERS IN THE LIBRARY

Gary Bartimas[1] and Norman Bell[2]

ABSTRACT

This report focuses on strategies for using microcomputers in a wide range of applications in the school library. The activities reported will be those related to assisting students in the use of computers to enhance their effectiveness in school-related activities. These activities have proved to be successful over the past several years in the Department of Defense Dependents School in Alconbury, England. Also included in the report are accounts of several of the activities being planned for future implementation.

INTRODUCTION

With the continued acquisition of microcomputers in the K-12 environment, there is an increasing opportunity for individuals directing the school libraries to include in their programs a focus on the microcomputer and its application in the learning setting. Because there has been a tendency to place in the library the media resources for the school, it is natural in many schools for the microcomputers also to be put under the jurisdiction of those in charge of libraries. It then becomes the task of those librarians to identify the procedures and to design programs to enable the students to make effective use of computers. This has been the situation in the Alconbury Elementary School, one of the Department of Defense Dependents Schools in England. Reported in this paper are details of the various ways in which computers have been used with students in the library setting, ranging from introductory keyboard drill to word processing and introductory computer programming using the Logo language. Included also is an explanation of the difficulties encountered in applying computers in the library setting, and some of the strategies presently employed to overcome such difficulties. Some of the plans for future use of computers by upper elementary students to gain access to research materials through the use of retrieval systems.

A BRIEF STATEMENT OF THE PHILOSOPHY OF THE LIBRARY OPERATION

In describing the general purposes of the media center operation within the traditional school library setting, the overarching goal is to meet the needs of as many students as possible by providing a setting with the following three characteristics. First, the media center provides a supervised setting in which individual work can be done by the students. It is a room separate room which provides a quiet setting, apart from the typical classroom, making it easier for students to work independently. Second, the media center is free of class structure. Consequently, the students are allowed to work according to their own desires for independent study. The normal constraints present in the typical classroom do not need to be implemented in the media center. Third, in order for the time spent by students to be worthwhile, support systems have to be available. In the media center there are present a variety of such systems which can be used by students as needed. Included in these support systems are certain devices to increase the efficiency and effectiveness of the students. The computer functions well within this third characteristic in that it is a device which can be used to accomplish something while at the same time it is a learning tool by which students can conduct curricular-based analyses allowing them to compare, develop, predict, and make decisions. Consequently, these three characteristics become the basis for the philosophy of operation.

---

[1] Librarian, Alconbury Elementary School (DoDDS), Alconbury, England

[2] Professor, Michigan State University, East Lansing, Michigan

THE COMPUTER WORKSTATIONS

The Alconbury Elementary School Media Center has the following configuration with respect to microcomputer capabilities. There are ten workstations grouped in one location on tables. Included in each workstation is an Atari 800 (or 800XL) with a single disk drive (either an Atari 825 or 1050), and an Amdex color monitor. There are eight printers available for these twelve workstations. The printers include two Epson FX-80's, three NEC P2C's, and three Atari 825's.

The remaining two workstations are set apart from these ten systems for independent use by students. The time constraints that have been placed on the use of this equipment is as follows. First, for half of the instructional day, ten of the systems are reserved for instructional purposes in which groups of students will be working on similar activities with the comptuers. Second, during the other half of the instructional day, the ten systems are reserved for independent use by students on an "as needed" basis. Third, the two additional workstations are available throughout the entire day for use by individual students, again on an "as needed" basis.

DESCRIPTION OF GROUP INSTRUCTION AVAILABLE

The library media specialist has prepared instructional presentations to be made to groups of students whose teachers have determined that skills in using microcomputers will enhance the scholastic capabilities of their students. The following is a listing of these presentations by grade level.

Grade Level	Topics
K - 3	• Keyboard Identification, using *Kids on Keys* • Computer Operation • Curricular-Based Problem Identification: i.e., letter, number, shape identification, visual/motor skills
4	• Keyboarding Introduction, using *Typing Teacher* • Introduction to Logo
5	• Keyboarding Drill and Review, twice per week for 12.5 minute intervals throughout the entire school year • Introduction to Word Processing, using *Bank Street Writer* • Logo Programming
6	• Keyboarding Drill and Review, twice per week for 12.5 minute intervals throughout the entire school year • Word Processing Review, using *AtariWriter Plus* • Advanced Word Processing Concepts • Introduction to Data Management, using *Home File Manager* and *Synfile*, for development of class bibliography, individual bibliography. • Introduction to On-Line Data Base Searches

SUMMARY OF EXPERIENCES WITH COMPUTER CURRICULUM

With the major emphasis on keyboarding and word processing, this summary of experiences will first focus on these two activities. As was expected, it was found that the 4th grade, though they could display the correct keyboarding techniques, were not, as a group, as proficient as the 5th and 6th grades. About a third of the 4th graders showed enough skill, discipline, and concentration to do extended word processing. The 5th and 6th graders, with a few exceptions, all were able to keyboard on command, though it was found that only a few would actually use correct keyboard procedures when working independently. However, it does appear that the students are able to carry over skills from year to year, and those students who had received instruction in keyboarding and word processing the previous year were much more able to move ahead with their skills. In a recent lesson, a group of ten 6th graders were able to word process a full page of text in just about thirty minutes. It seemed as if that much data entry would require more than thirty minutes, but the students were able to handle that amount of text with little difficulty.

Regarding the Logo instruction, it appears that the most efficient means to introduce Logo to early elementry students is by bringing the system into their classrooms and having the media specialist demonstrate Logo. The introductions were given to students in groups in their own classrooms. A demonstration computer with a large screen television was taken to the classrooms and the students were given lessons in the purpose and use of the Logo language. For the first and second grades, Logo is only used on a demonstration basis. Such an experience is designed to stimulate them concerning uses of computing and to prepare them for future use of the language. For the third graders, the Logo is used in the library with students grouped at the machines for the purposes of entering and executing simple procedures.

Having the fourth and fifth graders come to the library for hands on operation of Logo has been a most adequate way of following up on the initial introduction. By following these strategies, it appears that the students are able effectively to learn the programming concepts related to Logo. It is expected that these concepts will provide a basis for some of the students as they later go on to more detailed programming classes in middle and high school courses.

COMMENTS CONCERNING DIFFICULTIES ENCOUNTERED

With respect to instruction in word processing, one major difficulty arose from the use of the 40-column word processor screens. To have such a little window for the activity of word processing seems to make it more difficult for the students to actually understand exactly what is going on in word processing. Especially difficult is to let them see the effects of the "cut and paste" procedures, since so little of the document can be seen at any one time. The problem is that in the use of the 40-column screen, what you see is not very much like what you get. In addition to the difficulties in cutting and pasting, the whole concept of page formatting becomes much more difficult with such a display restriction. It appears that an 80-column display would solve many of these difficulties related to word processing.

A second difficulty relates to the teaching of keyboard skills for word processing. It was found that it is difficult to teach keyboarding casually while demanding that finger placement be maintained and good keyboard skills be practiced. It appears that unless the discipline of keyboarding is greatly encouraged, and even required, the students will revert to their old habits when they are using the computers for their own word processing. Consequently, time and effort have to be placed on the management of the drill periods so that the students will become proficient enough with their keyboard skills such that when they operate out of the confines of the drill period, they will still want to use the keyboards properly.

FUTURE ACTIVITIES

Because the program, as it is operating presently, appears to be quite successful, the proposed changes for the future are more involved with adding activities rather than making major program changes. For example, as more of the 80-column screen and word processors become available there will be an increased emphasis on activities related to making formatting changes and viewing these changes on the screen prior to sending the output to the printer.

In addition, with the more powerful microcomputers becoming available for use in the library, there will be added to the program detailed instruction on the use of retrieval systems for the gaining of access to research materials. Related to this aspect of computer use will be the compact disk read-only memory systems containing the standard research materials. Prior to the arrival of the CD-ROM, the students will be provided with the opportunity to do on-line searches. This aspect of the computer use will be made available to the students as modems and telephone lines become available, and as such resource material is available through local telephone calls. A partial solution to such an access problem has been solved in some school districts by the initiation of their own bulletin board systems on which the reference materials are placed. Students then are able to gain access to such material on the basis of a local call. Granted that such research information may not be as extensive as that which would be available in the professional information services, or the CD-ROM information systems, the students would be able to learn how to use such systems as they retrieve the information placed on the systems for their use.

With the arrival of the more powerful microcomputer systems, it is expected that some of the standard library operations will be automated. However, since these aspects are not directly related to student use of the computers, their implementation and subsequent use will not be explained in this report. However, it is obvious that whenever the library operation is improved, student learning will be affected since the library personnel will be able to spend more time with individual students helping them learn to use the library and its resources to improve their learning.

SUMMARY

The program implemented in the library at the Alconbury Elementary School has a variety of goals, all aimed at assisting the students to make better use of all the resources provided in the school. By providing instruction in keyboarding and word processing, it is felt that the students are being given a tool which will be useful throughout not only their academic lives, but as long as they have the need for communicating using the written word.

Through the introduction of Logo, the students are being exposed to some of the more important concepts of programming which they will be able to use as they are later involved with computer courses in the school, and also at any time in their lives when they have the opportunity to make use of the computer in ways which demand more programming skill. The use of the more modern data bases, such as dBaseIII, those setting up the system find that programming experience is a most helpful prerequisite.

Instruction in the use of retrieval systems and communication devices provides the students with valuable experience, especially since the use of such systems is rapidly increasing. It is expected that such retrieval systems will become more widely available as the CD-ROM systems become incorporated into school libraries. As these changes take place, the students of the Alconbury Elementary School will find that they have had good preparation and that they will immediately be able to make effective use of such tools.

THE IMPACT OF NEW TECHNOLOGY ON THE ACCOUNTING CURRICULUM

J.E. Shaoul*

ABSTRACT

This paper analyses the way that the new, relatively cheap, user friendly, technology and the associated software is changing the way that accounting is being taught. Techniques that have been available, in principle, for years, are now widely available. The newer techniques stress decision making for planning and to a lesser extent, control, in contrast to the older technology which in the accounting context is more appropriate for transaction processing and control. The impact on the curriculum, the teaching methods and other pedagogic issues are discussed. The problems of introducing the new equipment are outlined and the benefits are assessed.

INTRODUCTION

It is important to stress that the advent of microcomputers means that techniques, such as financial modelling, that have been available in principle, for years, are now widely available. The old technology, mainframe computers, and the associated software, were relatively scarce, costly and cumbersome to use, thereby restricting access to these techniques. Thus it is not that anything new, i.e. conceptually impossible twenty years ago, is capable of being done, but rather it is capable of being done by the many rather than the few.

Now with the availability of application software, anyone can use a computer to perform complex calculations, with minimal training and relatively cheap equipment. The newer techniques such as spreadsheets, database management systems, graphics, expert systems etc., rendered possible by the microcomputer, stress decision making for planning, and to a lesser extent control. It is an important distinction to make because the cheap technology is only an enabling factor, it is not important as a thing in itself. The different types of software mean that completely different uses will be made of the microcomputer, as opposed to the mainframe.

Compared to mainframe computers where users may assume any one of a number of user roles such as operators, data entry clerks, analysts, programmers and users of reports, personal computer users in accounting will need instruction in the theory and practice of all these tasks.

IMPACT ON THE ACCOUNTING CURRICULUM

This means that the design of information systems will become an essential part of the curriculum, in addition to the mainstream accounting subjects. Topics would include such issues as the system specification, design of screen layout, format of reports, data validation and the control and security of computer systems. Systems design and analysis is a very difficult course to teach in a classroom situation, relying so heavily as it does on practical experience,

*Department of Accounting and Finance, University of Manchester,
Manchester, M13 9PL.

knowledge of user behaviour, etc.; areas in which students have little prior practical experience. It implies teaching methods that give the students experience in different user roles. Films on the problems arising from inadequate specification or security can illustrate the issues more graphically than lectures.

In relation to the core accounting subjects, the new technology changes the educational methods. Spreadsheets have a wide number of applications in Finance, Financial and Management Accounting. It will be possible to set larger more realistic case studies, and to devote most of the class time to discussing the issues that arise, the assumptions, the limitations of the methods, etc. rather than going over the calculations.

Technology also has an effect on learning as a social process. Given that larger, more realistic case studies can be set and that equipment may be in short supply, the opportunity exists to set group work. Students thereby learn to work in teams rather than individually and competitively. They learn a wider range of social skills than are currently fostered in accounting courses. Project work requires them to cooperate with each other, divide the tasks, coordinate, lead and discuss with one another. This type of learning situation makes them less dependent on the teacher and more dependent on each other. Most learning is in fact a social process, but the change in technology makes this more obvious.

However, students do need help in this to understand the generalisability of their experiences - that they are not unique experiences peculiar to them. It becomes possible thereby to teach them some of the problems involved in project management, e.g. to see why some groups had crises and others did not and what could be done to minimise their effects or to avoid their occurrence altogether.

There are a number of interesting ways that class assignments may be used. A series of exercises may be set that make use of the previous results as a building block. Projects, to be done as a team, may be set. One of the drawbacks of this type of work is that there may not be the time to give students adequate feedback about their work.

One way round this is for all the groups in the class to make copies of their work, which they distribute to their colleagues and the assignment is for them as the senior manager, to review the plans, budgets etc. of all the groups, including their own. This requires them to assume a different role and to study other people's work and analyse them critically and to see the implications for their own work. Emphasis should be given to criticising their own work. This type of assignment avoids the problem of how to assess an individual's contribution to the team. An individual assignment such as this gives each student the chance to participate as part of a team and to make his/her own assessment of the work. Most students said they learnt a lot by studying the way that other people tackled the problem.

The software that is available such as spreadsheets, database management systems, operational research techniques etc., are usually seen as decision support tools for managers. It is important that if they are to be used in this way that students appreciate the problems raised by the appropriateness of the data. If they are to be taught to become decision makers, they need to be given case material that is wide ranging, not simply numbers to manipulate. Too many exercises in decision making stress detached, calculative rationality rather than involvement and intuitive and inferential reasoning.

Another aspect of the computer technology that should be mentioned is word processing. In Britain, students typically turn in handwritten work which is often poorly presented and difficult to read. Undoubtedly, word processing (and the use of graphics) improves the presentation of the work (and reduces staff marking time), but from an educational point of view, there is another advantage that should be considered. Because it is so much easier for students to correct their work or even to add to it, the content as well as the form should also improve. The technology alters the way that people work. It is no longer necessary to leave writing up to the last. It can be done alongside other tasks in the knowledge that it can be easily altered as they are going along.

Thus it is clear that the new technology is having some impact on the curriculum and that innovative methods of instruction and assessment follow on from these changes.

PROBLEMS IN INTRODUCING NEW TECHNOLOGY

These changes are undoubtedly very expensive, both because of the cost of the hardware and software, and since business departments required few additional resources other than teaching staff, there is no mechanism within the budget for either capital expenditure or perhaps even more importantly, recurrent expenditure for running costs and maintenance.

The new technology is usually administered within the department rather than by the computer centre. This entails extra work for the staff involved. In addition, the lack of computer expertise among the staff teaching the core accounting courses and their uncertainty about the pedagogic benefits of introducing them into the curriculum means that computer management and development typically falls unequally on the few who have this expertise.

There are few formal incentives in terms of promotion and tenure to administer the computer facilities and even less to develop good computer based materials for other courses. Additional technical and administrative support is usually needed.

Not only is it costly in terms of staff time to acquire the technical skills and develop course material, the newer educational methods are also costly in staff time. They involve a higher degree of informal staff/student contact time, and additional running costs e.g. computer availability beyond normal office hours, additional library resources etc. Thus the introduction of new technology raises questions about the University's ability to commit resources to staff training and educational development.

There is a contradiction here. Whereas in industry and commerce, new technology is introduced to improve productivity/reduce costs, within the teaching function of the University, it raises the revenue requirements without incurring any obvious cash savings to the University. The public sector is bearing the cost of training students in the new technology for the benefit of the employers.

As accounting and business departments become more capital intensive and require more specialist skills, it can only accelerate the trend to reduce the number of institutions where these subjects are taught, i.e. it is likely to increase the mergers/closures of departments.

All these considerations show that the introduction of new technology in business and accounting departments meets severe constraints from the existing organisational structure and lack of finance. But it will be difficult to implement the new educational methods if these questions are not tackled.

A REPORT ON INNOVATIONS IN COMPUTERS IN EDUCATION

Colonel D. L. Hosley, Ed.D.*

ABSTRACT

This report describes four initiatives that the United States Air Force's Ira C. Eaker Center for Professional Development (CPD) has taken to further use of computers within professional continuing education in a military setting. Limited theory guided research and application in this environment has prompted this report. The first initiative described is a prototype center for computer-assisted instruction where learning activities can be performed in a non-intrusive academic setting. The second initiative addresses a uniquely configured laboratory designed to teach international students English as a second language. This laboratory will explore the effectiveness of interactive videodisc (IVD), particularly digital as opposed to analog. The third initiative provides an overview of an Air Force software management program for general officers and senior executive service members. The fourth initiative focuses on a research consortium to enhance innovations in computerized education.

INTRODUCTION

In recent years many changes in higher education and management have taken place. Rapid technological advances and changing student and practitioner needs have all contributed to this significant change. Microcomputers, auxiliary devices, videodiscs, software, and associated curriculum models have all made their way in increasing numbers into institutions of higher learning. CPD has been no exception to this rapidly developing trend. This report on innovations in computers in education is intended to show how selected advanced technologies will be utilized in a key Air Force continuing education program. These four initiatives focus upon basic and applied research in instructional methodology, curriculum development, and inter-institutional cooperation.

OUTLINE OF REPORT

Center for Computer-Assisted Instruction

Computer-assisted instruction (CAI) has had over a 25-year history in the United States Air Force. In 1985, CPD commenced study on creating simulated educational environments where theoretical situations could be enacted. In order to conduct more empirically-oriented research on the best ways to achieve CAI-desired goals, Air University Headquarters designated CPD's Academic Instructor School (AIS) as the CAI Center of Excellence within Air University. To facilitate this activity, Air University approved an initial $200,000 for the project.

The concept for the center has now been developed, equipment has been installed, and the center became operational in January 1988. The center will focus upon basic and applied research in instructional

*Department of the Air Force, USA, CPD/CC, Maxwell Air Force Base, Alabama 36112-5712 technology, and will offer instruction to those who will use CAI technology in educational institutions throughout the Air Force. Instruction will focus sharply on the use of microcomputers and interactive videodiscs (IVDs) in educational skills development, authoring systems, selected computer-generated instruction, micro-computers, and remediation as adjuncts to traditional military instruction. A key center objective is to use a CAI distributive integrated system. To support the above instruction and associated research, the center contains a fully equipped microcomputer laboratory with IVD capability, prototype electronic classroom, and spacious screen micro-computer supported projector for large auditorium use.

The center's mode of operation is based on subsystems to stand alone, and integrated where appropriate. The basic approach of this plan is to develop systematically each segment of the system, reserving expenditure of dollar resources until additional segments are warranted. Other significant aspects of the center are to utilize CAI in developing skills such as educational planning, curriculum problem solving, and instructor decision making. The center will incorporate a longitudinal follow-up evaluation of students to examine long-term program results and required changes. Research will also explore ways in which CAI and IVD might be used to teach advanced educational concepts, instructor attitudes, tactical and strategic educational planning.

Interactive Videodisc (IVD) System Development

Interactive videodiscs have gained a new role at CPD's International Officer School (IOS) in instructoring international officers to speak and understand American English and United States military terminology. The IOS is now using this technology to provide their students with "surrogate experiences" by involving them in pre-programmed language simulation exercises.

IOS has now acquired 21 student workstations and connecting Z-248 computer support systems with 40MB hard disc capability. Each station has, a Pioneer 4200 videodisc player, a Sony PVM1271A NTSC/RGB monitor with Carrol infrared touch panel graphics overlay and internal digital audio card. IOS will now purchase an off-the-shelf IVD English course. This will be used as supplemental material to a customized course that uses approximately 30 segments of "Raiders of the Lost Ark." English instructional language exercises have been written by the faculty based on this film. To date $284,000 has been committed to this IVD program.

IOS has concluded that communication and not structure is central to effective IVD language learning. While information on laserdiscs cannot be altered, users can jump among the many frames of still photographs, moving video, and graphics. What is distinctly unique about this IOS initiative is that the OASYS authoring system is used to mix digitally stored audio and graphics with the analog content of the videodisc. The individual workstations operate as stand-alone units. They will also be linked using a fast operating local area network (LAN). This LAN will allow the rapid up and down loading of information to and from the main station. A 70MB file server will store information for the entire laboratory. This IOS system will also allow for some conventional CAI presentations, especially as they support communication skills development.

Another IOS-IVD planned innovation is to integrate videodiscs into the curriculum at minimal cost. This can be done by "repurposing" existing discs. This will involve IOS faculty writing or contracting for a new computer program to dictate how material on the disc is to be presented. This will eliminate the expense of collecting slides, filming action language segments, and requiring an all-new videodisc.

Software Management Instruction

In 1987, CPD was tasked to develop and implement a senior- level education program in the area of software management. The curriculum, currently under development, is targeted to the most senior military and civilian leaders within the United States Air Force. The objectives of this program are to provide an overview of Air Force software management for general officers and senior executive service civilians. The program also provides a top-level view of the leadership challenges that face senior leaders in a world of ever-increasing software dependence. The criticality of this educational effort stems from the rapid and explosive trend of military dependence upon high technology, and in particular, computer software. The Air Force Chief of Staff has labeled it the "Software Crisis." Because this dependency has appeared so recently, many senior leaders are lacking in the fundamental understanding of the technologies involved. Shallow understanding of computer technology and the resulting shortcomings in control over its acquisition and deployment further complicate the situation.

It is within this environment that we must provide senior leaders with the education they need to better lead the Air Force in a software dependent world. CPD is, therefore, developing an integrated facility that will allow a full range of presentation formats, from lecture, to seminar, to panel discussions, while utilizing microcomputer equipment for demonstration and hands-on applications. The facility, will contain thirty-two networked microcomputers built into student consoles. The computer only becomes evident when in use. The podium will also contain a microcomputer and full audio-visual and lighting controls. This includes remote controls for a video projector mounted in the ceiling for projecting video tapes, closed circuit and standard broadcasts, as well as displaying the monitor output from the podium computer or from any one of the student computers. This feature is provided by a switching device, also located in the podium, which allows the instructor to not only display any monitor output, but "take over" keyboard control from any machine or "give" keyboard control to any machine. The switcher also allows the instructor to designate group leader machines which then can network with other student machines to form independent groups for projects. Instructional content and methodologies will be built around the utilization of this integrated facility. No longer will classroom and the "computer lab" be separate entities. Instruction can easily transition from lecture to demonstration to hands-on. CAI packages and custom built software will also exploit this capability, where technology can be used in a comfortable, on-demand fashion—to enhance, emphasize, or interactively supplement instruction. The purchase, utilization, and management of software will be addressed in two separate senior officer courses. Software to be high-lighted by senior students are: operating systems, computer languages, and application programs. Currently, $686,000 has been initially identified for this program.

Partners in Educational Research: A Consortium

Our final initiative involves Partners in Educational Research (PIER). This is an educational research consortium with joint participation by federal, industrial, and civilian educational agencies. CPD will be the executive agent, AIS will be the research platform, and participants would constitute the research partners. The consortium will test the effectiveness of various hardware and software configurations in computer-based instruction. The major consortium will uncover causal relationships and problem solving in electronic educational technology. This will be principally undertaken within CPD and in the field where similar CAI and IVD projects are underway. As media initiatives become more firmly developed, our research design will address specific problems, selection of relevant variables, hypotheses development, collection and analysis of appropriate data, and finally drawing and mutually sharing conclusions about the relationships of the variables examined. Within AIS, CAI laboratory equipment are ideal for establishing a sound research base for basic, demonstration, or applied research. Also, class sequencing, a heterogeneous student population, mixed military and civilian faculty, and a well-established evaluation system provide greater control of research variables. The benefits to accrue from this consortium are numerous. To the civilian educational community come results to further advance CAI technology. To CPD come results from research, the contract price of which would be prohibitive if the Air Force were to contract for a comparable study. To the external participants come results from a ready made cost-effective research platform.

CONCLUSION

The establishment of the Center for Computer-Assisted Instruction by the Ira C. Eaker Center for Professional Development at its Academic Instructor School is a notable educational initiative to enhance individualized learning, interactive study, and immediate student feedback. The introduction of interactive videodiscs within the International Officer School is consistent with current theories of second language acquisition in that it provides realism, instant feedback, and individually selected progression through English as a second language. The need to provide a top-level view of the leadership challenges that face senior Air Force leaders in ever-increasing software dependence has reached crisis proportions. These initiatives have promising and significant long-term educational results. To keep our CAI efforts on-target a consortium is being established between the military, industry, and leading civilian educational institutions. This support team association will provide the applied research, testing, and program refining necessary to establish and maintain a CAI-IVD educational undertaking.

REFERENCES

Allen, M. W. "Authoring Aids: The Means to Improved Authoring Procedures." Technical Report TR-1986-2. Control Data Corporation, Minneapolis, Minnesota, 1986.

"OASYS Author's Guide." Distributed by: Online Computer Products, Inc., Germantown, Maryland, 1987.

Parsloe, E. Interactive Video. Sigma Technical Press, Cheshire, United Kingdom, 1985.

Tennyson, R. D., and Welsh, J. C., Christensen, D. L., and Hajovy, H. "Interactive Effect of Information Structure, Sequence of Information, and Process Learning Time on Rule Learning Using Computer-Base Instruction." Technical Report TR-1985-6. University of Minnesota, Minneapolis, Minnesota, 1985.

THE HUMAN IMPACT OF TECHNOLOGY IN SCHOOLS

Burl Hogins * **M.A.**

ABSTRACT

Computers have become an everyday part of life in the United States -- and of schools in the United States. The author reviews traditional American teaching methods briefly and then examines how computers are transforming that tradition. In particular, he discusses the "human impact" technology is effecting on teaching, and more importantly, he argues, on learning.

INTRODUCTION

When computer were first introduced into schools, many of us educators in the United States were threatened by them: we were concerned that they might cause us to lose the "personability" that we associate with the favorite teachers we had as students. And we were concerned that we would lose control of the learning process.

Of course, our concerns really came out of a fear of the unknown: what could computers do, anyway? How could they possibly enhance a classroom or school environment without taking away from what the teacher had done?

Let's examine what changes computerized curriculum are effecting on education in the United States.

But first, let's briefly review our educational system in the United States. While reforms have come and gone in our system of education, one thing has not changed in 200 years of teaching: how school is conducted.

BACKGROUND: KIDS TUNE OUT SCHOOL

Our teachers stand in front of rooms of children with various learning abilities. Some of the children have already fallen behind so what the teacher says doesn't make sense to them, and they fall further behind. Some of the children learn better by seeing than hearing, so they tune out. And some of the children are just plain fidgety. These three groups make up approximately half of any U.S. classroom. And by an early age, most of these children will have been labeled "at risk," or "slow learner," or "learning disabled." It's only a short while before they identify themselves with those dehumanizing terms and come to think of themselves as failures, and for most, it's just a few more years before they leave school early.

* Senior Vice-President and Co-Founder, Education Systems Corporation (ESC)
San Diego, California

This description of school and of education may sound harsh, but it is fair. The fact is that nationally almost half—and over half in urban areas —of all children leave school early. And the decision to leave early is not suddenly arrived at by most of these students—it is one formed by years of unproductive, unfulfilling and uninteresting educational experiences.

COMPUTER-ASSISTED INSTRUCTION (CAI) HELPS KIDS TUNE IN

This is indeed a grim scenario. What has the power to change it? Computer-assisted instruction. The reason is clear: computer- assisted instruction (CAI), offers all students individualized instruction that stimulates kinetic learners, visual learners, and aural learners.

Anyone who has been in the presence of two children of the same age for more than an hour will tell you how different the two are, and how those two children learn differently. That's where CAI comes in: it allows the two children to learn in their own way at their own pace. The computer allows children to explore their own learning strategies, and take possession of their own learning. By take possession of learning, I mean that they get so excited about learning that they are willing to take responsibility for the learning, just so they can learn more. The experience of completing a lesson or of mastering a subject is so rewarding that they want to do it again and again. And they are proud of what they are doing.

STUDENT ATTITUDES IMPROVE WITH CAI

The idea that children might want to learn, might like to learn, is an educator's dream. The sad reality is that we rarely see children light up over learning: that's why CAI is so exciting, and in a way, perhaps a little incredible. Who could imagine that reading and mathematics would be rewards for good behavior? But that's exactly what they are in Lexington, Kentucky in the U.S. It's a model city in the sense that most of his elementary schools have a computer lab. Students are rewarded with extra time in their computer lab, where they are learning reading and mathematics, if they behave well. Teachers say that rewarding the students with computer time for good behavior really works: the students love their CAI that much.

The students' love for learning isn't limited to the computer lab either. Teachers all over the United States say that their students are more attentive, read directions more carefully, and take greater pleasure in the process of solving problems in the classroom as a result of using the computer lab.

STUDENTS LEARN WITH COMPUTER-ASSISTED INSTRUCTION

There's no doubt that CAI is successful in helping children learn. Several schools in the United States have reported gains on standardized tests, after introducing CAI on a regular basis to their students.

For educators, CAI has a few other bonuses. Students who receive CAI on a regular basis are getting better results on their standardized tests, regardless of socioeconomic or cultural differences. And teachers are being given a tool that allows them to manage the educational process better. The tool is a computerized report that shows what is being taught in the computer lab, what is being learned, and what needs to be worked on, in the lab or in the classroom.

Teachers, assigned to large classes, with students of multi- ethnic backgrounds and experiences, can use the report to help them quickly understand how a student is learning, and what can be done immediately, in the classroom or in the computer lab, to help that student learn more effectively.

CAI MOTIVATES STUDENTS TO TAKE RESPONSIBILITY FOR LEARNING

What is it about CAI that motivates children so much that they want to take possession of their learning? It's patient. It only goes as fast as the child goes, not because it understands the child, but because the child must tell the computer to continue by pressing a key. Some CAI programs will repeat themselves, again at the child's request. It doesn't play favorites. And it doesn't discriminate between students. So students who can't relate to the teacher well because of cultural or social differences can still relate to the computer. It pays attention when the student needs attention. In a large and busy class, the teacher cannot give immediate personal attention to everybody at once. Some students always will have to wait. And some of those waiting students will get discouraged. But CAI can respond immediately to every student with more questions or help. It rewards every child for being a successful learner. No matter what level, if a student gets an answer or concept correct, he or she is rewarded with visual and aural praise, in the form of words and music, and sometimes even animation.

With CAI, students take responsibility for what they are learning, because they like what they are learning. Teachers are better able to look at each individual's learning patterns and needs. The end results, in addition to good test scores, is increased enjoyment of learning, and for many children, a chance to boost their self-image through learning.

QUALITIES OF GOOD CAI

Still, not all CAI is created equally: Those educators who want good CAI software should look for CAI that is based on the premise that every child can learn, and that positively reinforces the child for learning. It should be motivating, with color and sound, and the curriculum content should be solid. Finally, no CAI is good unless it has a management system that is easy to use and to understand. Student progress reports should be clear and simple to read, and teachers should be able to see how classroom curriculum correlates to the laboratory curriculum, and vice versa. A popular type of CAI which can provide solid motivating curriculum is called an integrated learning system (ILS). Many U.S. educators use ILS's as a "total solution" to their computer curriculum needs.

CONCLUSION: CAI CAN HELP TRANSFORM EDUCATION

Will computers transform the American classroom? I'm convinced the answer is an overwhelming "Yes!" With a good CAI system in the school, educators can use the computer for teaching the 3 R s, as well as for teaching "computer skills." And what's learned on the computer can be integrated with what's going on in the classroom. That's exciting. And it's rewarding, to teachers and students alike.

GRAPHS AND EDUCATIONAL COMPUTERIZATION OF RECREATIONAL MATH

M.A.Murray-Lasso*

ABSTRACT

An example of computerized recreational mathematics, graph tracing without lifting the pencil or retracing lines, considered an enjoyable introduction to "arid" topics in the teaching of mathematics to children and adults alike, is presented . The theory and the principal procedures in LOGO are exhibited. Comments to turn the programs into a semi-intelligent tutor are given.

INTRODUCTION

Recreational mathematics is a motivating way to introduce "arid" mathematical topics to children and adults alike. [Ref. 3] Coupled with the computer, it is doubly motivating, additionally providing, in a natural way, practice on data structures, algorithms and recursion for the software writers. Many puzzles such as mazes, jug-pouring, cannibal and missionary crossings, shortest routes,and 14-15 games yield to graph theory. In this paper we present the topic of tracing graphs without lifting the pencil or retracing lines. We present some LOGO programs for this problem and make comments for turning them into a semi-intelligent tutor.

HISTORICAL AND MATHEMATICAL BACKGROUND

Our puzzle has an interesting history going back to the creation of graph theory by the famous mathematician Leonhard Euler. [Ref. 1] He gave a complete solution to the celebrated problem of the Koenigsberg bridges. In the town of Koenisgberg in Prussia which is crossed by the two-branched river Pregel there were seven bridges conecting the mainland to the Kneiphof island as shown in Figure 1. The problem consists in devising a walk which will cross all seven bridges once and once only. Euler proved that it was impossible to devise such a trip and in doing so gave the necessary and sufficient conditions for deciding in arbitrary problems of the same nature when they have a solution and when they do not. The bridge problem can be modeled by a graph by representing each distinct land area with a node and each bridge connecting two land areas with an edge. The graph corresponding to the map of Figure 1 is shown in Figure 2. Notice that distances and the precise position of the nodes is immaterial, all that matters are the connections between the land areas by the bridges. A trip is represented in the graph as a route starting at one of the nodes and traversing all edges in succession without retracing any of them to end in a final node (which may be the same as the initial node.) Such a route is called an Euler path in graph theory.

---

*National University of Mexico, President, Mexican Society for Computers in Education, Rembrandt 53, Mèxico 19, DF, 03910 MEXICO.

Although Euler did not spell out in detail how to obtain an Euler path, if one wants to program a computer to solve problems of this nature it is necessary to detail an explicit algorithm. The algorithm used in this paper is based on a popular proof [Ref. 2] of the sufficiency of the Euler conditions for the existence of an Euler path in a graph which is stated in the following

Theorem: The necessary and sufficient condition that a connected graph have an Euler path is that the graph have either two (case A) or zero nodes (case B) with an odd number of incident edges. In case A the Euler path should start at one of the two special nodes and end at the other. In case B the path can start at any node and end in the starting node.

Proof of Sufficiency: For case B: Start the path at any node. Traverse edges one after the other in an arbitary fashion without retracing any until it is no longer possible to continue because there are no untraversed edges leaving the node in which you are standing. Since for each node visited, except the first, you entered and left it using an even number of edges, if there are no untraversed edges incident to the node in which you are standing, you must be back in the first node. (If you were at any node other than the starting node you would have arrived at such a node possibly after entering and leaving it one or more times but having used an odd number of edges, hence there would still be an edge in which you could leave it given that all nodes have an even number of incident edges.) Now, either you have traversed the whole graph, in which case you have a solution, or a piece of the graph in which each node is incident to an even number of untraversed edges touches at least one of the nodes visited, given that the graph is connected. By the simple artifice of inserting a traversal of the untraversed piece of graph before exiting one of the touching nodes, the traversed graph can be made definitely larger while keeping the condition that all nodes remain with an even number of incident untraversed edges. By applying the technique as many times as necesarry the whole graph will eventually be included. For case A: Starting at one of the two nodes with an odd number of incident edges, traverse edges arbitrarily until you can no longer continue because the node you are at has no more untraversed edges. That node must be the other node with an odd number of incident edges, for you have used up an even number of edges for all the intermediate nodes in the traversal and an odd number for the initial and final nodes. If you have not traversed all the edges, then the untraversed portion consists of nodes all of which have an even number of incident edges and at least one node touching the traversed portion of the graph, given that the graph is connected. Using the artifice of inserting a closed traversal from one such node, the graph can be made to grow, always keeping the untraversed part with an even numer of edges incident to each node. Eventually the whole graph will be included.

ENTER THE COMPUTER

We represent a bidirectional edge as two edges with opposite orientations (both having the same number to identify them) with the proviso that we can only use one of the two edges in any construction. The method we use to represent the graph in the LOGO language consists of numbering nodes and branches consecutively and storing, for each node, a list consisting of the node number considered as a temporary origin and a list of pairs having as first element a node that can be reached directly from the temporary origin through a branch plus the corresponding branch number. In this manner, the graph of Figure 2 is represented by the LOGO list:

```
[[1[[3 3][3 4][2 1][2 2][4 5]][2[[1 1][1 2][4 7]]][3[[1 3]
[1 4][4 6]]][4[[3 6][1 5][2 7]]]]
```

The first step in the automatic solution of the tracing problem is testing the sufficiency conditions of Euler's theorem. The number of branches incident to a node is the count of the numer of pairs in the LAST of the item corresponding to the node. Next, assuming the conditions are met, the program proceeds to traverse the graph starting from an appropriate node and moving to any neighbor removing in doing so both the pair that takes it to the neighbor as well as the one in the neighbor's list of pairs that goes in the opposite direction. While doing this, lists are constructed of the nodes visited and branches traversed. This is continued until one of the lists of pairs is empty. At this point, either all the lists of pairs are empty, in which case a solution is at hand, or a closed traversal can be found starting at any node among the nodes visited which has a non-empty list of pairs. This traversal can be inserted in the list of nodes visited at the proper place to make a larger traversal. The method is applied recursively until all lists of pairs are empty. The lists of nodes visited and edges traversed are the solution. A practical program will include portions for capturing a description of the graph, drawing and labelling it, capturing the user's tracing solution, checking its validity and interacting with the user. Space does not permit us showing the listings of procedures for all these chores, so we only exhibit in Figure 3 the procedures for the symbollic process described above.

CONCLUSION

We exhibited computerized tracing of graphs without lifting the pencil or retracing lines, giving the theory behind the puzzle and commenting on its implementation on the computer, showing the principal procedures. To turn the program into a tutor it should be capable of telling when a graph is not connected or is otherwise invalid, does not satisfy the Euler conditions to be traceable, when a sequence of nodes and edges do not belong to the graph, when there exists retracing and when not all edges are traced or the order of tracing is improper. With adequate interaction and diagnostics a program can behave as though it understands what the student is doing and thus qualify to be labelled as an intelligent or semi-intelligent tutor. [Ref. 4].

REFERENCES

1. L. Euler, "Solutio problematis ad geometriam situs pertinentis, *Commentarii Academiae Petropolitanae, Vol. 8,* (1736), pp. 128-140. An English version appears in "The Koenigsberg Bridges", chapter 20 of *Mathematics in the Modern World*, (Readings from Scientific American) W. H. Freeman and Company, San Francisco, (1968).

2. W. T. Tutte, *Connectivity in Graphs.*, University of Toronto Press, London, (1966).

3. Y. Perelmân, *Matemàticas Recreativas*, Editorial Mir, Moscû, (1982).

4. T. O'Shea y J. Self, *Learning and Teaching with Computers: Artificial Intelligence in Education*, Prentice-Hall, Inc., Englewood Cliffs, N.J., (1983).

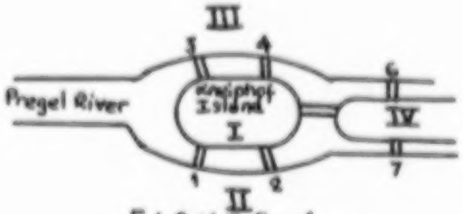


FIGURE 1

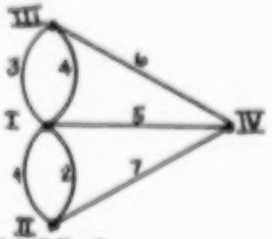


FIGURE 2

```
TO TRAZA (Note: Text between () denotes comments)
MAKE "NORA ARMA :NA (LIST :NA) [] MAKE "NOD FIRST :NORA
MAKE "RAM LAST :NORA  IF (COUNT :NOD)=(:RR+1) [STOP]
MAKE "PL 1 OP RECICLA :NOD :RAM (PL used to insert traversal)
END (NA is starting node, RR is number of edges in graph)

TO ARMA :NA :NOD :RAM
MAKE "X ITEM :NA :GRA IF EMPTYP LAST :X [OP (LIST :NOD :RAM)]
MAKE "P FIRST FIRST  BF :X MAKE "NS FIRST :P MAKE "R LAST :P
MAKE "Q (SE :NA :R) (SUST :A :B :C replaces top level element
B by A in first appearance of B in list C; ELIM :A :B elimi-
nates top level element A from list B)
MAKE "GRA SUST (FPUT :NA (LIST ELIM :P FIRST BF :X)) :X :GRA
MAKE "GRA SUST (FPUT :NS (LIST ELIM :Q FIRST BF (ITEM :NS   !
:GRA))) (ITEM :NS :GRA) :GRA (GRA is list representing graph)
MAKE "NOD (SE :NOD :NS) MAKE "RAM (SE :RAM :R)
OP ARMA :NS :NOD :RAM (NS is the next node)
END  (! denotes line continues)

TO RECICLA :N :R
MAKE "NA FIRST BF :N MAKE "X ITEM :NA :GRA
IF NOT EMPTYP LAST :X [MAKE "NORA ARMA :NA (LIST :NA) [] OP !
(LIST INS BF FIRST :NORA FIRST FIRST :NORA :NOD INS LAST     !
:NORA ITEM :PL-1 :RAM :RAM)] (INS :A :B :C inserts A right
after first appearance at top level of B in list C)
OP RECICLA BF :N :R
END
```

FIGURE 3   Principal Procedures

AN APPROPRIATE CONTINUUM OF PROGRAMS LEADING TO INFORMATION PROCESSING TEACHER CREDENTIALS: THE TEXAS MODEL

D. G. Knezek*

ABSTRACT

Texas has recently put into place new programs to complete a continuum of university-based teacher credentials which are designed to address needs of both schools and individual educators in the area of information processing. Two levels of this continuum rely on endorsements added to currently held teacher or administrator certificates to document progressive levels of competence with information processing technologies applied to schooling; the third level is an enhancement of the full teacher certification in computer science. Teachers, administrators, and teacher educators were formally surveyed to establish the general inadequacy of existing programs in embracing new technologies available for education. Training programs in place that were tangentially related to information processing were of limited utility and were unevenly implemented. New and upgraded program provisions for educators involved with information processing technologies were formalized so as to be more globally applicable.

INTRODUCTION

Use of information handling technologies, including computing, permeates all viable personal, educational, vocational, and professional futures of school age children throughout the "high-tech" world. These technologies hold promise, too, as tools and media to assist professionals engaged in instructional activities within our schools. A decade of energies have been expended in education's struggle and search for effective approaches to providing knowledge, skills, and attitudes that are likely to be relevant to futures of both students and educators. As educational innovators have pursued the elusive goal of projected relevance, fundamental teacher education in the area of information processing technologies has been neglected. Education and training for school and program administrators, to this point, has been equally deficient. Following is an effort by the chief researcher and author of Texas' new Information Processing Technologies endorsements to characterize that state's efforts to address this issue.

CONDITIONS WARRANTING PROGRAM DEVELOPMENT

Particularly over the last decade, schools in Texas have experienced tremendous pressures to bring computing to their students. Many of these pressures arose from individuals external to schools who saw computing and information processing within society in general far outdistance use of similar technologies in the schools. Projections of ever widening gaps among educational and other institutions in the use of information technologies, and projections of a world of vocations and professions which require high levels of technological sophistication on the part of exiting students fueled the urgency of the situation. Too often, the resulting move toward information processing in school, particularly in instruction, was plagued by ill-defined purpose, poorly formulated curricula, inadequate resources and instructional materials, and inappropriate systems. Almost universally in levels below post secondary education in Texas administrators and teachers lacked the training and expertise necessary to adequately address these problems.

---

*Division of Edcuational Technology, Texas Education Agency, 1701 North Congress Avenue, Austin, Texas 78701 USA, and The University of Texas at Austin, Department of Educational Administration.

Because in the U.S.A. responsibility and authority for education through grade 12 resides with individual state governments, these problems became burdens of Texas' state education agency. In December of 1980, an ad hoc committee on computers in education was formed within the Texas Education Agency to develop objectives for the Agency, and to propose actions and placement of responsibilities to deal with these issues. In that committee's first report in April of 1981, a decision was made by the members to focus on short-range goals for immediate action. This limit was due in part to the early realization of the interactive and complex nature of needs in this area and of the limited expertise among agency staff related to educational computing. Some disturbingly enduring areas of concern were identified in 1981 -- rapid proliferation of computers in schools; inappropriate uses of computers in the school setting; need for guidance, information, and technical assistance regarding the acquisition and use of computers; impact of untrained administrators and teachers; inadequacy or lack of evaluative data regarding the effectiveness of computers in education; and rapid changes in the industry itself. Recommendations of that committee included a suggestion that the Agency "establish a single contact point under the Associate Commissioner for General Education as special consultant on Technology in Education," and it was further recommended that the office "assume prime responsibility for coordinating ... staff development activity ... where technology in education is concerned."

Largely due to the efforts of this committee, an Office of Instructional Computing was established within the Agency in 1982. That office evolved into the current Division of Educational Techology. Through early initiatives from this office the Texas State Board of Education in 1984 adopted the nation's first minimum competency requirements for junior high school teachers of computer literacy. This action followed closely a state mandate requiring every student in Texas to take a one-semester computer literacy course in either grade 7 or 8. Prior to being assigned to conduct this required course, teachers had to demonstrate competency in computer literacy by passing an examination based on the prescribed computer literacy curriculum. That curriculum is laboratory-based and includes awareness, introduction to information processing tools, and exposure to computer programming. These mandates saddled Texas with an immediate, massive, and highly visible shortage of qualified teachers of computer literacy. A temporary turnkey inservice training effort was mounted which in 18 months allowed over 8000 previously certified Texas educators from a wide spectrum of fields to be certified as competent to teach computer literacy. This urgent need in the area of computer literacy proved, however, to be only the tip of a much larger iceberg, and the training and verification effort proved only partially effective in addressing even that tip.

Both formal and informal field input indicating inadequacies in teacher training for educational uses of information processing had risen to a substantial level by the beginning of the 1985-86 school year. It was evident, too, that concern extended beyond the designated "computing" courses. Levels of dissatisfaction with the status quo were formally probed through three opinion surveys in 1986. Groups surveyed included the general membership of the Texas Computer Education Association in February; college and university personnel from education and from computer science within teacher education institutions in April; and elementary, middle, and secondary school educators in June. Results were conclusive.

Three out of every four working educators responding to these surveys indicated that more computer training should be required of teachers using computing in their curricular and program areas. Of the eleven courses identified as "computing" courses in the survey, only two were identified by a simple majority of respondents as having adequate teacher preparation programs leading to required certification. Chart 1 focuses on a few selected courses to illustrate the variance in magnitude of the problem. Note that only approximately 10% of surveyed educators working in business education identified teacher credentialing programs for Introduction to (Business) Computer Programming as adequate; mathematics educators responded similarly for Computer Mathematics I.

RESPONDENTS VIEWING CURRENT REQUIREMENTS AS APPROPRIATE

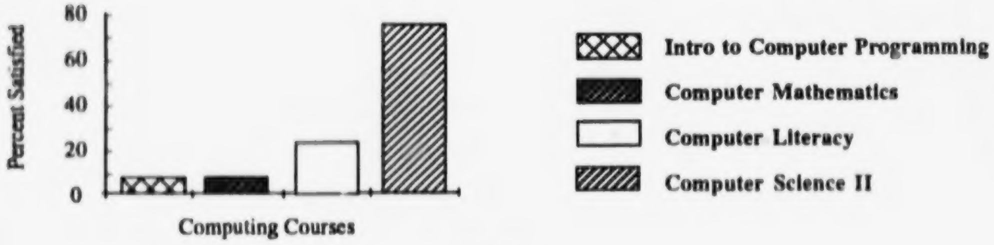


CHART 1

Clearly there was a widely perceived need for improvement in this area.

RATIONALE FOR A CONTINUUM OF PROGRAMS

Through the same set of surveys, broad-based support for proposed program development was also documented. The core of proposed improvements consisted of a two-level teacher endorsement (a supplemental credential to initial teacher certification) titled Information Processing Technologies (IPT). Only one teacher education institution of the 45 responding indicated they would not offer programs leading to the endorsement if it were in place. Seventy percent of educators responding to an adequacy item indicated that the proposal would address current teacher training and credential needs.

The rationale is to provide and require a general cognitive awareness level of training for all candidates for teacher certification in the application of information processing technologies. This level should provide a fundamental understanding of what tools are available and what the general uses of each are in education. Thus, a course (or demonstrated competency) requirement for all aspiring teachers forms the foundation of program specifications for teacher education related to information processing. A step beyond this initial orientation is a training level designed to bring educators to an operational skills level in the use of information processing in their program areas. Level One of the IPT endorsement is intended to document that a teacher is a "skilled craftsman" with these tools as they are applied to instruction. That is, the educator is capable of effectively applying information processing to make instruction more effective and has the ability to bring students to an effective skill level in interacting with the systems used. Diagram 1 illustrates the hope that the group at this first level of improved competence will be a substantial sub-population of all educators.

Levels of Expertise with Information Processing Among Texas Educators

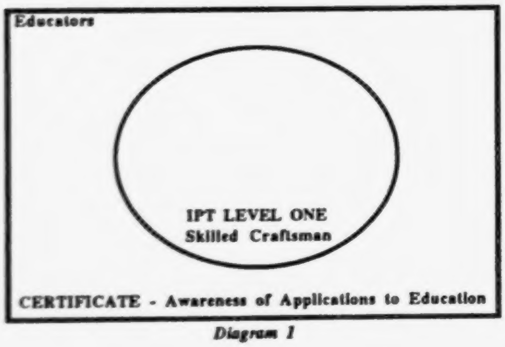

Educators
IPT LEVEL ONE
Skilled Craftsman
CERTIFICATE - Awareness of Applications to Education

Diagram 1

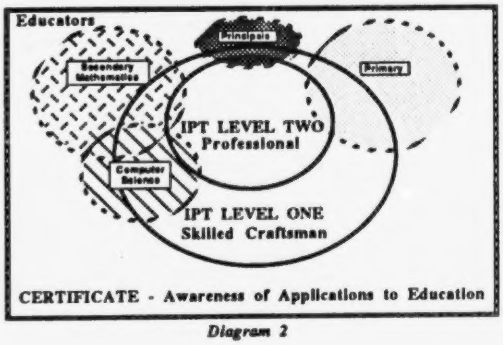

Educators
Principals
Secondary Mathematics
Primary
IPT LEVEL TWO
Professional
Computer Science
IPT LEVEL ONE
Skilled Craftsman
CERTIFICATE - Awareness of Applications to Education

Diagram 2

Within this Level One group of educators a smaller guiding group of individuals will gain a highly professional level of education, not only in their primary area of expertise, but in the application of information processing to programs within that primary area. Level Two of the IPT endorsement should document an educator's ability to take a programmatic approach to design and evaluation of the use of information processing in her/his particular area of expertise. Members of this talented and educated group are professionals their respective fields with additional professional expertise in information processing. As illustrated in Diagram 2 on the previous page, any identifiable group within education will have some individuals within each level of preparation.

The levels discussed above are designed to provide incremental opportunities for educators to enhance what expertise they possess. The intent was to cause relevant training to become more widely available in teacher education institutions, to establish incentives to practitioners for continual training and improvement of skills, to provide schools with meaningful discriminators for personnel management, and to give guidance and direction as these unfold. The program certifying teachers to teach computer science at the high school level, on the other hand, requires the candidate to earn a minimum of 24 semester hours in the discipline and pass a moderately rigorous exit-level computer science exam. The intent in this teacher preparation component was to upgrade teacher teacher training programs so that computer science teachers would be computer science professionals as well.

FORMAL PROGRAM SPECIFICATIONS

New general education requirements for all teachers in Texas include three semester hours of instruction in educational computing and technology, or, alternately, demonstration of competency in that area. Content related to educational computing and technology is to include social, ethical, and educational implications; use in delivery of instruction; use as a productivity tool; use in teaching problem solving; selection of appropriate courseware and systems; and fundamentals of information processing.

Level One of the IPT requires a minimum of 9 semester hours including at least 6 of these at or above the third university year level and including the following content: (1) background information concerning information processing technology (including at least terminology, applications, ethics, impact on society and education, hardware configurations, future trends, historical development, and basic system architecture); (2) operational skills and familiarity with current information processing tools (including at least tools used for word processing; information storage, retrieval and display; numerical computation, analysis, planning and reporting; transmission of information; graphics production and display; design and manufacturing; and emerging information processing tasks); (3) methodology for instruction in concepts and skills of information processing (including at least strategies for delivery of concepts and skills, evaluation techniques, methods of modifying curriculum for special students, automated management strategies, teaching methods for keyboarding instruction, and facility management and maintenance); and (4) modern programming (including at least experience solving problems using computer programming; application of a program development cycle; program structure, modular design and style; in-depth coverage of syntax, format and common uses of one primary high-level programming language). Level Two requires 15 semester hours with at least 6 at the third year university level or above and adds to the programming component a contrast of a second programming language with the first. It also adds the additional component of (5) technology-based delivery and management of instruction (including at least evaluation of software and courseware, techniques and concepts of technology-based instruction, systems for automated management of instruction, comprehensive systems involving both delivery and management, educational applications of artificial intelligence, authoring systems, multi-technology instructional systems, and survey of other promising technology-based systems).

APPLICATIONS OF MICROCOMPUTERS TO OPERATIONS RESEARCH IN EDUCATION

R.G. Taylor*

ABSTRACT

The present paper reports the outcome of a three-year effort to study the prevailing use of Operations Research methods in education, to determine the applicability of such methods to educational management, and to provide microcomputer software and other technical resources to educators who wish to explore and use operations research methods. The purpose of the study is to assist educators, primarily educational administrators, in their efforts to make optimal decisions.

COMMENT

The techniques known as "operations research methods" are frequently employed in industrial engineering, military science, business administration, and other fields. These methods rarely appear in the practice and literature of education, even though they have a clear relevance to many of the problems and decisions faced by educational administrators.

Educators have been slow to adopt the techniques of Operations Research for several reasons: 1) Until recently, most of the methods required access to a mainframe; with the advent of powerful microcomputers and programs written by the present author and others, this barrier no longer applies; 2) Most of the methods are complex and required mathematical sophistication; graduate level business educators overcame this barrier with applied courses in Operations Research and Management Science; the present paper proposes that the curriculum for future educational leaders include such applied courses.

The project began in 1985 as an organized research theme by the present author; the project has been significantly advanced by several collaborators, most notably by political scientist and planner, William Michael Reid. Financial support and other resources have come from research trust funds, small grants-in-aid from the School of Education at North Carolina State University, but mostly from direct contributions to the project by its collaborators.

The topical structure of the project follows:

1. The analysis of network problems
2. Decision making under risk and uncertainty
3. The optimization of linear functions
4. The analysis of transition matrices
5. The analysis of waiting-line problems

*Professor and Head, Educational Leadership and Program Evaluation, North Carolina State University, Raleigh, NC, USA

THE ANALYSIS OF NETWORK PROBLEMS

The project concerned itself with three general types of network problems. The first pertained to the scheduling and management of activities, wherein each branch of the network represents an activity and each node the junction of one or more activities. Typical of such analyses are those provided by PERT/TIME and PERT/COST. The second type of network problem considered was that which links all nodes via a minimum or a maximum span. The third type finds the shortest route from one specified node to another.

At the time this report was prepared, work had been completed on PERT/TIME and minimum span. Work is in progress on the shortest route problem, and has not yet begun on PERT/COST and maximum span. In terms of PERT/TIME, the project's focus was on documenting the oversimplified manner in which researchers within educational administration used PERT, and on showing that a more complete understanding and use of the technique would yield far more satisfactory results. A microcomputer program for completing these more complex calculations was developed as part of the project.

With regard to minimum span, the technique has been virtually unused by educators. The project's focus was, therefore, to build awareness by publishing illustrations and explanations of the method; a micro program has also been developed as part of the project.

DECISION MAKING UNDER RISK AND UNCERTAINTY

Many decisions in education are made under conditions of substantial uncertainty. This uncertainty derives from the dynamic nature of the educational environment, its participants, and its processes. As a result, most events occurring in educational systems can only be estimated or predicted.

Given the uncertainties which characterize educational management, the suggestion that many decision makers have difficulty using probabilistic information is unfortunate. The current project embraced two broad attempts to familiarize educational leaders with probabilistic and predictive techniques. The first pertains to the value of information and is based on Bayesian analysis. The second pertains to enrollment forecasting. Both pieces of this work are completed and have resulted public-domain software packages for microcomputers.

A Bayesian analysis is not commonly understood or used by researchers in education. The project has, therefore, adopted the same goals with regard to Bayesian analysis as it has to the spanning problem, that is, to build awareness, generate illustrations, and to provide technical support through microcomputer programs. To date, the public-domain package has been completed and tested and a single illustration has been developed and submitted for publication.

At the time of writing, the enrollment forecasting problem is receiving maximum attention. A review of the literature indicates that this topic received some attention in the late 1960s and early 70s, and that most of the work on forecasting in education has been confined to the repetition of certain ratio techniques. Ratio techniques, most notably "cohort survival", may be the best methods to use in enrollment forecasting, but the more modern forecasting techniques, as developed in other fields, should be examined for their potential to improve accuracy.

THE OPTIMIZATION OF LINEAR FUNCTIONS

For two reasons, one of the earliest pieces of work undertaken by the present project was to study the use of linear programming in educational research. The first reason is that linear programming is sometimes regarded as the preeminent method of operations research; indeed, catalog descriptions of introductory OR courses occasionally mention nothing other than linear programming. The second reason is that the first real problem presented to the project was amenable to a linear programming solution; that problem and solution launched the project and resulted in two published reports, one with an emphasis on the method, and the other on the application.

After surveying the generally available literature on linear programming in education, it was determined that the project should prepare and publish one or two general illustrations and then move on to those areas of linear programming that have been less commonly used. Further, microcomputer programs in the public domain and commercial micro programs are available; this further narrowed the focus of the present project. See, for example, the public-domain Kinetics Linear Programming package (Copyright, 1984, Kinetics Software, 1390 Fell St., San Francisco, CA 94117)

There are numerous special topics in linear programming, such as goal programming, integer programming, zero-one programming and mixed integer programming. At the time of writing, an integer programming software package, developed as part of the current project, was being tested. It requires, as input, an optimal relaxed solution via the Kinetics package or some other source, and then it returns an optimal integer solution. Initially, this package will solve only minimization problems. An illustration of integer programming, pertaining to the planning and budgeting of high school student activities, is near completion.

THE ANALYSIS OF TRANSITION MATRICES

The principal tool for evaluating transition matrices is Markov analysis. A transition matrix is a square array of probabilities which indicate the likelihood of passing from one state to another. Such matrices are of two general types, absorbing and nonabsorbing. The project has dealt with both.

The use of the Markov technique requires several conditions. First, there must be a finite number of discrete states. Second, the transition probability of moving from one state to another in one time period must be independent of all prior states except the current one. Third, the total of all transition probabilities of moving from a given state to an alternate state in the next time period must equal 1.0.

Fourth, these probabilities must be reasonably constant over time. Finally, all the information needed to construct a complete transition matrix must be available. The absorbing problem has additional requirements including the presence of at least one absorbing state and at least one path from each nonabsorbing state to at least one absorbing state.

Markov analysis, which has many applications in business and industrial decision-making, is one of several probabilistic models common to management science. The applications of Markov models in educational planning have been confined generally to student flows and enrollments.

Since the educational literature did include evidence of at least a limited use of Markov analysis, the development of an illustration and an explanation of the technique was not needed. Instead, a formal research study was undertaken. The purpose of the study was to determine the practicality and the effectiveness of the Markov method for the purpose of projecting teacher salaries, and to compare the results with more traditional methods.

THE ANALYSIS OF WAITING LINE PROBLEMS

One of the earliest and most detailed aspects of the project was the development of queuing model software and its application to original research in educational policy analysis.

Queuing problems take on a variety of forms, but all relate to solving some aspect of the waiting line problem. Those forms involve combinations of fixed and variable policy problems, single and multiphase waiting lines, and single and multichannel service mechanisms. A common waiting line problem in education is the single-phase, multi-channel, flexible-policy problem; such a problem was chosen as the initial demonstration for this project.

A survey of the literature on the use of queuing models in education indicates that most existing applications are in higher education. One application that is particularly noteworthy pertains to determining the number of terminals needed to support public access to online library catalog systems. The queuing model could be equally well applied to any number of problems in education -- lunch lines, ticket sales, athletic gates, counselor appointments, etc..

The work started by others, as cited above, was continued by the project and expanded to address educational policy issues. A software package was developed that undertook two major tasks, the first of which appears to be unique: the computation of multiple queuing solutions sorted by policy, and the computation of detailed queuing information once a policy is selected.

The author would be pleased to provide readers with a much more detailed report and with copies of microcomputer programs, in exchange for postage, copying and handling.

THINKING WITH A PROGRAMMING LANGUAGE: AN INTRODUCTION

H.A.Peelle*

ABSTRACT

This paper reports preliminary efforts to understand how computer programmers think while using APL (A Programming Language). Originally conceived as a unifying mathematical notation, APL has become successful as an interdisciplinary programming language for computer applications in business, engineering, scientific research, mathematics, and education. Recent studies begin to reveal why APL is effective as a tool of thought. Examples of APL thinking are illustrated here in simple programs for descriptive statistics. Also mentioned is I-APL, the new public domain APL software designed expressly for microcomputers in schools.

INTRODUCTION

APL is one of the most popular interactive programming languages in the world, yet little is understood about how it affects thinking. Distinctive among computer languages, APL appears to foster new ways of solving problems, generally characterized by parallel processing of multi-dimensional arrays -- in contrast to computing one item at a time, looping, and monolithic programs typical of traditional programming languages.

APL programmers often claim that APL is an attractive problem-solving tool because it affords a rich selection of powerful primitive functions and operators, easy definition of additional functions (programs), consistent syntax, and concise expression of algorithms. Sometimes programmers can articulate ways of thinking with APL such as: selecting appropriate combinations of functions to manipulate arrays, picturing intermediate transformations in their minds, using idioms, and working top-down or bottom-up or inside-out -- but, for the most part, the cognitive processes involved beg to be investigated further.

Accordingly, this paper is introductory. It exposes rudimentary thinking processes involved in APL programming -- well shy of describing the full effects of APL on problem-solving *per se* (which include problem representation, algorithm development, heuristic strategies, etc.) More sophisticated examples of APL thinking appear in (ref 1). The paper introduces only aspects of APL needed for simple examples of well-known programs in statistics, namely: mean, variance, standard deviation, and correlation. An introduction to the APL language is given in (ref 7).

---

*University of Massachusetts, EDUC #10, Amherst, MA 01003 USA

STUDIES OF APL THINKING

A variety of approaches have been employed in order to study how computer programmers think while using APL: (a) Review of relevant literature. Opinions about APL thinking found in APL journals were collected and presented as part of a keynote address at the SIGAPL seminar "APL as a Tool of Thought" in New York in April 1986. (b) Study of how APL is learned and taught. From a congnitive science perspective, we analyzed errors ("bugs") novice programmers commonly make while learning APL and proffered a working taxonomy of such bugs (ref 2). We also identified issues inherent in teaching APL, along with mistakes sometimes made by APL instructors and pedagogically problematic aspects of APL's design (ref 3). (c) "APL Thinking" course. We designed and taught an experimental graduate level course at the University of Mass. where we analyzed students' methods of thinking with APL and informally compared them to ways of thinking in other programming languages such as Pascal, LOGO, and LISP. (A new course, "Teaching Mathematics with APL", is now offered for teachers.) (d) Interviews of professional APL programmers. We asked programmers in the field to describe how APL affects their problem-solving. (e) "APL Thinking" Panel. We conducted a panel discussion on this theme at the APL86 international conference in Manchester, England in July 1986. (f) Survey. We surveyed the APL community via mail, distributed a questionnaire at the APL86 conference, and disseminated our findings in APL Quote-Quad (a quarterly journal of the ACM) (ref 4).

Further, there are some promising educational projects currently underway. For instance, Dr. Kenneth Iverson, inventor of APL (see ref 5), is introducing APL to Canadian school systems. Norman Thomson of IBM U.K. Labs offered a workshop for math teachers in Winchester, England last summer. Tandy-Radio Shack awarded a grant to Professor Howard Peelle at the University of Massachusetts to design an elementary mathematics curriculum in APL. And, I-APL was announced this past year. I-APL (International standard APL) is a new public domain software package -- including interpreter, documentation, and instructional materials -- designed for schools' 64K microcomputers such as Apple II, BBC micro "B", Commodore 64, IBM PC, and Sinclair Spectrum (ref 6). Further, APL workshops for local teachers were offered at the APL87 conference in Dallas, Texas and at APL88 in Sydney, Australia.

Results of our studies have begun to reveal why APL is an effective thinking tool. To begin with, APL utilizes a unique character set comprised of symbols. Many of the symbols come directly from mathematics (e.g., + - × ÷); a few are borrowed from the Greek alphabet (e.g., ρ measures the shape of an array); some symbols replace implicit or inconsistent notation (e.g., * is used for exponentiation and ← for assigning variables); and some are new symbols created for computing purposes (e.g., → for branching and ⎕ for input).

Most APL symbols are mnemonic; that is, their visual appearances suggest their functions, or their placement on the keyboard is reminiscent of their names (e.g., *?* is above Q, for Question mark and is used to generate random numbers). APL has no reserved words. So, any use of natural language requires the programmer to create the words desired (say, for variable or program names); otherwise, all computations are done with symbols.

EXAMPLES

As an indication of the nature of APL thinking, consider the following brief examples of programs for basic statistics. The "mean" can be expressed in APL simply: `(+/N)÷(ρN)` (where N is a list of numbers, +/N adds up the numbers, ρN counts how many numbers, and divides the two results, as indicated with parentheses). While this is certainly direct and concise, it also entails knowing: the functions of symbols (here +/ and ρ and ÷), the concept of variable (here, N), data representation in an array (here, a list of numbers), and a new kind of control structure (here, the operator / which applies the function + throughout an array). Further, this expression may be given a name in order to define it as a "program", thus:

```
      ∇ R←MEAN N
[1]     R←(+/N)÷(ρN) ∇
```

(where ∇ indicates the beginning & end of program definition, [1] is the line numbering provided automatically by computer, MEAN is the name chosen for the program, N is the name of its input, and R is the name for the result). It is necessary to realize that actual numbers must be given in place of N at the time the program is executed, like this:

```
      MEAN 60 70 80 90
75              (The result is printed at the left margin.)
```

This program may be used in building other, more complex programs, such as the following program for "variance":

```
      ∇ R←VARIANCE N
[1]     R←MEAN (N-MEAN N)*2 ∇
```

(where the MEAN of N is subtracted from each of the numbers in N, these differences are squared, and then averaged by program MEAN). Cognitively, this involves the idea of parallel processing, as well as the use of subprograms. Parallel processing occurs here when a single number (the result of MEAN N) is subtracted from each of the numbers in N -- producing a list of numbers as a result -- and also again when each of those numbers is raised to the 2nd power (by *). Using MEAN as a "subprogram" involves understanding that the set of primitive functions (provided as symbols on the APL keyboard) may be extended for application in a specific area (here, statistics) by defining programs and allowing them to be used in defining additional programs, etc. This leads to the wise practice of "modular programming", that is, defining small programs, testing them separately, and then assembling them later into larger programs.

For instance, VARIANCE is used to define "standard deviation":

```
          ∇ R←STDEV N
     [1]    R←(VARIANCE N)*.5 ∇
```

(where * to the .5 power computes square root). Then this can be used (with MEAN) to define "standard scores":

```
          ∇ R←STANDARD N
     [1]    R←(N-MEAN N)÷(STDEV N) ∇
```

which, in turn, can be used to define "correlation":

```
          ∇ R←X CORRELATE Y
     [1]    R←MEAN (STANDARD X)×(STANDARD Y) ∇
```

Other examples from statistics can illustrate more aspects of APL thinking. See (ref 1) for a program to find "median" using a general APL expression to handle several cases at once, obviating the need for branching. See (ref 7) for a program to compute "mode" (and frequency distributions) by creating a higher dimensional array and then reducing it; use of ⌹ to compute linear regression coefficients; and use of ? to generate random simulated data.

RELATED ISSUES

Even this introductory exploration of APL thinking raises some larger issues which deserve further attention, especially as use of APL in education grows: Does easy availability of powerful primitive functions imply that "thinking in APL" means doing more (by computer) but thinking less (by students)? How are the APL symbols perceived, understood, and used in actual problem-solving -- especially by mathphobic students? Is APL's lack of inherent linguistic bias an advantage for programmers from other cultures? Is APL viable as an alternative mathematical notation? Perhaps further understanding of APL thinking will tell.

REFERENCES

1. M Eisenberg & H Peelle, "APL Thinking: Examples", APL Quote-Quad, Vol. 17, No. 4 pp 433-440 (1987)

2. M Eisenberg & H Peelle, "APL Learning Bugs", APL Quote-Quad, Vol. 13, No. 3 pp 11-16 (1983)

3. H Peelle & M Eisenberg, "APL Teaching Bugs", APL Quote-Quad, Vol. 15, No. 4 pp 86-93 (1985)

4. M Eisenberg & H Peelle, "Survey of APL Thinking", APL Quote-Quad (to appear in 1988)

5. K Iverson, "Notation as a Tool of Thought", Communications of the ACM, Vol. 23, No. 8 pp 444-465 (1980)

6. E Cherlin, "I-APL Introduction" (editorial), APL News, Vol. 19, No. 3 pp 9-12 (1987)

7. H Peelle, APL: An Introduction, (Holt, Rinehart & Winston, NY, 1986)

THE INFLUENCE OF THE INTERFACE ON INFORMATION RETRIEVAL

F.M.T. Brazier & J.J. Beishuizen*)

ABSTRACT

The design of an intelligent tutoring system requires the design of an interface component. Little research on the effects of the interface on the interaction, and thus on the other components can be found.

To investigate the influence of an interface implementation two information retrieval systems, GRASS and QUEST, were first analysed and then tested in a field experiment. The two systems were designed for the identical tasks of (among others) selection, retrieval and sorting of data using the same semantics (the objects, attributes and actions involved). The syntax of the systems, however, differed greatly: GRASS is a menu-driven system and QUEST a command-driven system. Differences in learning and strategies employed for information retrieval were examined by confronting 22 subjects with both systems, the necessary tasks and tests.

The command driven system proved not only to be perceived as being more efficient, the strategies employed also proved to be more efficient. The conclusion of this experiment is that an interface can influence strategies employed by subjects, and that this area should therefore receive more attention in research.

INTRODUCTION

One of the most promising fields which has emerged during the short history of computers in education is the field of "intelligent" tutoring systems (Sleeman & Brown, 1979). This relatively new field of research is developing slowly. The modules most often distinguished within such systems: (1) the subject matter expert, (2) the student expert, (3) the tutoring expert, and (4) the interaction expert, have not received equal attention. Developments within the field of Artificial Intelligence (e.g. Buchanan & Shortliffe, 1984, Clancey, 1982) have provided a basis for the acquisition and representation of knowledge found in the subject matter expert. The inclusion of cognitive style variables known from the field of Psychology to effect learning, has been advised (Tennyson & Park, 1987) but a working system has still to be found. Tutoring strategies have been studied by a number of researchers (Burton & Brown, 1982, Goldstein & Carr, 1977, Beishuizen 1986), but little consensus has been reached. The interaction component of such systems and its influence on the other components has received even less attention.

The design of an interface requires insight on the effects interfaces have on interaction. The inclusion of cognitive style variables in the model of the student will be of little influence if the interface inhibits the manifestation of their effects on learning. Research in the field of Cognitive Ergonomics provides a basis for interface design and evaluation. One of the frameworks for task analysis employed in this field is Moran's Command Language Grammar (1981, 1983) in which four levels of description are distinguished. This language not only provides a framework for the design and evaluation of a system, but it has also been used for the description of mental models users form of a system (van der Veer & Brazier, 1987). The four levels: (1) *task level*, the most abstract level, the level at which the tasks the system can fulfill are specified, (2) *semantic level*, the level at which the objects, actions and attributes involved are defined, (3) *syntactic level*, the level at which the implementation of the objects, actions and attributes is defined and (4) *key-stroke level*, the level at which the physical implementation (the functions of keys and knobs) is determined, all play a role in the functionality and efficiency of an interface. The syntactic implementation of the semantics, the syntax, involves both the specification of the sequences of manipulations involved in the execution of an action and the definition of the form or language of interaction with which the user is confronted.

---

*) Vrije Universiteit, Department of Cognitive Psychology, de Boelelaan 1115, Amsterdam, The Netherlands

Two information retrieval systems currently employed in British education GRASS (1985) and QUEST (1984), have been examined and compared on the basis of these four levels. The systems proved to be comparable at both task level and semantic level in as far as the selection, retrieval and sorting of data are concerned. The implementation of the objects, actions and attributes involved in the execution of these tasks, differed greatly: GRASS is a menu-driven system and QUEST a command-driven system. The execution of an action involves a different sequence of manipulations for each system: a series of menu entry choices is necessary for each action in GRASS, a command is required for each action in QUEST.

The influence of these differences at syntax level was examined in an experimental situation. The strategies employed for the retrieval of information and the ease with which the systems are learned, are the aspects addressed in this context.

METHOD

PROCEDURE

Twenty-two teacher-training college students majoring in Geography were taught to work with both QUEST and GRASS, the sequence of instruction in the systems differing for each half of the group. The two groups, formed on the basis of intelligence scores (spatial ability and analogies), were comparable. The experiment was integrated into a course on the use of information technology, participation was mandatory. A half hour introduction to data base systems in general was given to the class as a whole. The two groups were then formed. Each group was given thirty minutes' instruction on the system assigned. For comparison's sake the contents of the instruction was pre-defined and identical for both groups. QUEST subjects received a one page hand-out with an overview of the commands and of the syntax of a query with the relations which can be used. As the interaction required for GRASS is menu-driven, the syntax did not require extra written material support.

All students were given 22 exercises to complete in two different data bases in interaction with the system during pre-scheduled periods of 2 hours in Week 1, and 12 exercises in Week 2 in a third data base. The exercises provided for these training sessions were comparable to the questions covered during instruction, for example the task of finding out: 'Which volcanoes are active and higher than 5000 meter?', or 'Which volcano is the highest?'. The time required for the solution of these exercises was registered. All incorrect answers were returned to the students for reconsideration. During class in Week 3 the students were individually confronted with the experimental task, a number of questions of a type with which they were familiar. These questions pertained to the urban development in the city of Leeds, and were as such relevant to the students' course of study. The interaction with the system was recorded, answers were written on paper.

The following three weeks differed slightly. The instruction the students received on the second system was identical to the instruction on the first system. In Week 3 a questionnaire was presented instead of the experimental task. The students' subjective opinions of the differences between the two systems, of the types of tasks and people for which they are suited, and of the perceived transfer, were asked.

RESULTS

No differences could be found in learning times between the two systems. For both groups the interaction required to complete the exercises with the second system was less than for the first.

Evaluation of the strategies employed for the completion of the experimental task showed differences between the two systems. The degree of employment of the system is the primary factor of difference between the three strategies found. *Strategy A* is characterised by the use of a retrieval specification (query) to limit the number of items displayed. The subject's knowledge of the total set of items is thereupon used to interpret the relevance of the data displayed. In *strategy B* a retrieval specification is used to limit the number of items considered to the minimum. The values required are displayed, further interpretation is unnecessary. Minimum use of the system is characteristic for *strategy C* in which all items are displayed, interpretation relying fully on the subject.

The division of the frequency with which the strategies were employed is as follows:

	Strategy A	Strategy B	Strategy C
GRASS	9	9	4
QUEST	6	16	

Strategy B was most frequently used by QUEST subjects, strategy C was only used by GRASS subjects. The efficiency of the strategies in time is obvious if the average for each of the strategies and systems is examined. As the standard deviation was quite high, these times should be seen as an indication of the distribution of time over the strategies and nothing more. The least efficient strategy, strategy C, took GRASS subjects on average 8.6 minutes. Strategy A, the next less efficient strategy took GRASS subjects on average 5.0 minutes and QUEST subjects 5.5 minutes. The most efficient strategy, strategy B, took GRASS subjects on average 3.9 minutes and QUEST subjects 4.7 minutes.

A preference for QUEST was found in both groups of subjects at the end of the experiment, often motivated by the fact that QUEST was seen to be more efficient and faster. Thirteen subjects (6 from the GRASS-QUEST group and 7 from the QUEST-GRASS group) experienced positive transfer, three subjects (2 and 1) negative transfer. Two subjects (one from each group) experienced both types of transfer, the rest of the subjects did not know if transfer had occurred.

DISCUSSION

Differences in syntax between GRASS and QUEST did not result in differences in the time needed to master the systems. The decrease in time required for the second system for both groups shows that something more than just the operation of the system was learned in the first round. Information retrieval, as such, was reconsidered by the subjects. As QUEST involved more learning (namely the construction of commands as well as the semantics), it may be assumed that the structure of QUEST was more transparent.

If not in learning time where was the difference noticeable? In the strategies employed. The least efficient strategy was employed by 4 GRASS subjects and by no QUEST subjects, the most efficient by 9 GRASS subjects and by 16 QUEST subjects. The syntax of the interface seems to be of major influence on the way in which subjects employ the system.

The questionnaire shows that because of the efficiency experienced most students preferred QUEST.

The transfer experienced reflects justification of the similarity between the two systems at task and semantic level. Both negative and positive transfer can be expected: positive transfer at semantic level, negative transfer at syntax and key-stroke level.

The specification of the required interaction via commands instead of sequences of menu choices, has proven to be more preferred and to lead to more efficient use of the system. There are even indications that the use of commands was more transparant.

CONCLUSION

Not only is the interface of importance for the quality of the communication between the user and the system, it also influences the strategies employed by users. As Beishuizen (1986) has shown that strategies employed for information retrieval can be seen as traits of the user, the importance of the interface may not be underestimated. Further research in this field is warranted.

REFERENCES

Beishuizen, J.J. 1986. CIR: A computer coach for information retrieval. Proceedings of the EURIT 1986 Conference.

Buchanan, B. G. & Shortliffe, E.H. (Eds) 1984. *Rule-based expert sytems.* Reading: Addison Wesley.

Burton, R.R. & Brown, J.S. 1982. An investigation of computer coaching for informal learning activities. In D. Sleeman & J.S. Brown (Eds) *Intelligent tutoring systems.* London: Academic Press.

Clancey, W.J. 1982. Tutoring rules for guiding a case method dialogue. In D. Sleeman & J.S. Brown (Eds) *Intelligent tutoring systems.* London: Academic Press.

Goldstein, I. & Carr, B. 1977. The computer as coach: An athletic paradigm for intellectual education. *Proceedings of 1977 Annual Conference, ACM,* Seattle: 227-233.

GRASS, 1985. Graphics Searching and Sorting. An information handling package from Newman [illegible]ge, Newman Software, Birminghame.

Moran, T.P. 1981. The command language grammar: a representation for the user interface of interactive computer systems, *International Journal of Man-Machine Studies,* vol 15, 3-50.

Moran, T.P. 1983. Getting into a system. External-Internal task mapping Analysis. *CHI '83 Proceedings.*

QUEST. 1983. Edition 3, AUCBE, Hatfield.

Sleeman, D. & Brown, J.S. 1982. *Intelligent tutoring systems.* London, Academic Press.

Tennyson, R.D. & Park, O.C. 1987. Artificial Intelligence and Computer-Based Learning. In Gagné, R.M. (Ed) *Instructional Technolgy: Foundations.* London, Lawrence Erlbaum Associates.

Van der Veer, G.C. & Brazier, F.M.T. 1986. Users representations of systems: a methodological approach. To appear in *Proceedings of MacInter Symposium,* Stuttgart, 1987.

COMPUTER USE FOR PHYSICIANS: FACT AND FANCY

William M. Schmitt, M.D.

The use of the computer in medical education and health care delivery is mandated for continued updating in medical content, data and delivery, as well as patient education and faculty development. This study investigates the reasons why highly educated professionals do not use the computer more, what kind of professionals do use it, and recommends methods to enhance new users and support established users.

Introduction

Medicine and medical care needs constant updating to meet the new demands of our changing society. The education of these new changes involve understanding not only the content of the knowledge, but also the method/technique used and presenting the new content and measuring the effect of the change. Computer usage has altered the presentation of new material to be more efficiently, effectively and validly produced; thus, becoming a necessity for medical education. But, is this indeed true? Do physicians and residents in a community-based Family Practice residency program have the use of a computer at hand for educational uses? If they do use the computer, is it for continuing medical education, patient education? If they do not use the computer, why? Is it because they don't understand it, "don't like it", feel threatened by it, or really feel that it does not fulfill the role it should? Do they feel it's ineffective? If it is ineffective, how can it become effective? Four identifiable educational uses of the computer extend and involve the areas of curriculum development in medicine; patient care/education; continuing medical education; faculty development. This paper clearly defines the uses of the computer in medical education in a community-based hospital Family Practice residency program; surveys postgraduate fellows to their interpretation of the computer use in the evaluation of the computer use in these four educational areas.

In postgraduate medical education, computers are used in curricula in documentation of design, model development, measurements of core content and skills, testing methods and research technique. In faculty development defined areas of usage are teaching methods, audio-visual aids, application of teaching models and evaluation of change resulting from the teachings. The computer usage in techniques, methods, modules, processes becomes the goals of computer intervention for increased productivity. In content, computers present new, or changing concepts and review the established proven concept. While medical educators agree in the computer's importance and use, no evaluations have been done by postgraduate fellows or clinical precepting faculty for computers general usage and specific usage in the four educational areas in a community-based hospital. This paper will demonstrate evaluations of computer use completed by postgraduate fellows and clinical faculty members.

Method

Sixty-three clinical preceptors and twenty-one Family Practice residents were asked to evaluate computer use in their educational training in curriculum development/evaluation, patient care, continuing medical education and faculty development by questionnaire.

Results (See Table I)

Thirty-seven clinical preceptors and faculty members, or 59% of the sixty-three surveyed, and fifteen Family Practice residents, or 71% of the twenty-one surveyed, completed a questionnaire concerning the ability, availability of using a computer, and the quality of the computer use for the educational areas of continuing medical education, faculty development, patient education. Total responding fifty-two, or 62% of total possible eighty-four.

Discussion of Results

The survey responses show clearly the nil or infrequent use of the computer by both clinical faculty and residents in a community-based Family Practice residency program. Forty-six, or 89% of those surveyed had not used the computer to acquire continuing medical education hours, in faculty development workshops, and forty-seven, or 90% had not used it to instruct patients in education. This is an amazing number considering the use and effect of computers in all aspects of our lives. How could such educated and well-informed physicians and residents not have been introduced to the computer's use; especially, since all attend at least two weeks continuing medical education each year away from the residency program, and learn to instruct patients with the support of the computer. How can such educated people not be accustomed to a machine which is so ultimately involved with patient management and care. Why has this audience been overlooked? Or, why does this audience avoid the computer's use for education?

Forty-two, or 81% of those surveyed who have used the computer for continuing medical education have rated the computer's use below average for using new medical content; forty-one, or 79% rates below average to evaluate or to supplement a medical content data base, the respondents rated its use as simply average to good. Only one to three respondents thought it an excellent instructional instrument. However, from twenty-nine to thirty-one, or approximately 60% of the total surveyed would like to learn to use the computer, to learn new medical content, to evaluate and supplement known or newly acquired information.

Forty-three, or 83% never have used the computer in a faculty development workshop/program to learn new skills, to increase research ability, to increase evaluation skills, or for self-instruction. If used, ten, or 19% used it to learn new skills, nine, or 17% to collect research data; nine, or 17% to increase evaluation skills, and nine, or 17% for self-instruction. All rated it only average. However, forty-five to forty-six, or approximately 88% would like to use the computer for faculty development.

Twenty-three to twenty-six, or from 42-50% never used it for patient education. Do they not think it can be an instrument for learning? Do they not have time to educate with it? Do they not understand the potential of the computer for education purposes on a community level?

BEST COPY AVAILABLE

TABLE I

How many times have you used a computer? (choose one)	5 (greater than 7)	4 (5-7)	3 (3-5)	2 (1-3)	1 (none)
1) to acquire CME hours	2	1	1	2	46
2) in faculty development workshops	1	0	2	3	46
3) to instruct patients in education	1	0	1	3	47
I have used the computer for and rate its use:	5 (excellent)	5 (good)	3 (average)	2 (fair)	1 (poor)
CME					
1) to learn new medical content	1	8	0	3	40
2) to evaluate what I already know	2	6	2	3	39
3) to evaluate what I just learned	3	5	2	3	39
4) to supplement what I know	2	7	1	3	39
I would like to learn to use the computer:					
1) to learn new medical content	31	15	2	0	6
2) to evaluate what I know	29	15	2	0	6
3) to evaluate what I just learned	30	16	2	0	5
4) to supplement what I know	30	14	2	0	6
Faculty Development					
I have used the computer for and rate its use:					
1) to learn new practice skills	2	0	3	5	43
2) to increase my ability in collecting and using research	1	2	0	6	43
3) to increase my ability in evaluating evaluation skills	1	1	1	6	43
4) to instruct myself to teach well	2	2	1	4	43
I would like to use the computer better:					
1) to learn new practice skills	22	16	6	3	7
2) to increase my ability in collecting and using research	22	14	7	3	7
3) to increase my ability in evaluating evaluation skills	22	15	8	1	7
4) to instruct myself to teach well	22	16	5	2	7
Patient Education					
According to my observation:					
1) the quality of instruction for using computers in patient education is:	1	7	4	8	23
2) the present use of the computer for patient education is	0	4	4	12	26
I would prefer not to use the computer because (check one):					
1) I don't understand how it works	0	0	1	1	18
2) It is too difficult to use	0	0	0	0	6
3) I don't like machines	6	0	0	0	1
4) I'm computer illiterate	8	0	0	0	1
5) Technically exasperating	0	0	1	0	1
6) Other (complete)____________________					

When asked specifically for reasons in not useing the computer, "I don't understand how it works" was chosen twenty times, or 66%; "I'm computer illiterate" nine times, or 19%; "I don't like machhines" 7 times, or 15%.

Only seven, or 13% had a computer for practidcal use and only nine, or 17% were able to use it for education.

The surprising high percent non-use of the commputer for educational purposes in faculty development, continuing medicaal education and patient education illustrates that even though physicians and residents have a computer available for educational use, they do not use it.. Why? Do they not understand its function, its operation? Are they too tthreatened? How can such a modern, highly-educated physician not use an obviouus instrument to better himself and his/her patient care? Why are they soo apathetic to its usefulness?

Recommendations

Specific recommendations should include: a ffamiliarity with the "machine" via short introductory workshop sessions illustratiing its usefulness; a back-to-basics instruction of computer use, goals, conveenience; a pre-education and re-direction of postgraduate medical educations to objectiveness; suitable role models breeding comfortability and an ease of instruction.

Conclusion

Sixty-three clinical preceptors and twenty-onee Family Practice residents completed a questionnaire on general use of computeers and the specific uses of the computers in continuing medical education, ffaculty development and patient education. Amazingly, 89% learned physiciaans had never used the computer in continuing medical education, faculty ddevelopment or patient education in a community-based Family Practice resiidence program. Of those who had used it in continuing medical education or faculty development, approximately 19% rated it average to good. The innformation illustrates that perhaps computer education in continuing mediccal education, patient education or faculty development in a community-baased Family Practice program needs not to concentrate on software, discs, etc, bbut on the basics of answering why use a computer; how does it work; howw can I feel comfortable with it to help my learning process; and is it worth the effort?

BEST COPY AVAILABLE

A USER FRIENDLY END USER COMPUTING COURSE

K M O'DUBHCHAIR

ABSTRACT

The easy availability of microcomputer systems and application software has combined, over recent years, to produce a requirement for "end-user" information technologists. Every indication shows that commerce and industry consider it inappropriate to support this requirement with specialist computing staff but would prefer specialists in the specific area with acquired additional ability to apply information technology concepts. There is therefore a need for courses designed to give non-computing majors a firm practical grounding in IT skills and an understanding of underlying principles upon which they can base future developments.

This paper describes one such course.

INTRODUCTION

I should like to start by defining what I mean by "user friendly" and by an "end user" computing course. The latter I see as one specifically designed to meet the needs of an end user group in applying aspects of information technology. Perhaps it helps to differentiate and say what it is not. It is not a conversion course, ie it is not designed to cater for those who wish to become computer scientists. Equally validly it is not a computer awareness course. It is a course intended to give a working knowledge as opposed to an appreciation of computer applications. It is an "add-on" qualification intended to enhance and complement the user's original specialisation.

I use the term "user friendly" to describe a philosophy. Too often computer applications courses for the user population have been designed under the same premise as full-blown computer science courses and emerge as diluted versions of the latter. Non-cognate students majoring in other disciplines who wish to acquire information technology skills, in my experience, approach the subject with great enthusiasm but often exhibit symptoms of computer anxiety (ref 1). If this is not recognised or is ignored we do this student body a great disservice and may positively discourage further participation in computing. Our approach to the exposition of material will greatly influence the outcome and I suggest we should concentrate on making the inter-face "user friendly".

A DIPLOMA IN COMPUTER APPLICATIONS

Having perceived the need for this type of course the University of Ulster offers a Diploma in Computer Applications. The course is read over one year full-time or two years in part-time mode. In line with the definition above the course aims to advance the career prospects of graduates from non-cognate areas by providing them with a balanced education in, and a broad understanding of information technology as applicable to a wide variety of industrial and commercial environments. The objectives of the course range from giving the student the ability to effectively use computer applications and perhaps most importantly the ability to act as an interface.

Intake to the course has been from a wide variety of backgrounds and as the aim is to provide a general purpose experience no preference has been given to any particular discipline.

STRUCTURE OF THE COURSE

The structure of the course is based on 12 units including an individual project. Subject areas are:-

SEMESTER 1	Systems analysis and design Introduction to Programming Introduction to Data Processing Business Practice Computer Architecture and Operating Systems Microcomputer workshop
SEMESTER 2	Systems Analysis and Design 2 Programming Methods Database Management Systems Communications and Networks and Security Artificial Intelligence/Man Machine Interface Microcomputer workshop 2

The course is primarily microcomputer based and centres around use and application rather than intricate details of hardware and software. In this we would concur with the approach taken in other institutions, (Ref 2). Particular emphasis is placed on the practical acquisition of skills in the different areas and the ratio of lecture to practical is a minimum of 1:2. The majority of practical work is based on Olivetti microcomputers in an Ms-Dos environment. In the microcomputer workshop sessions students become highly familiar with a range of generic software - word-processing; spreadsheet; database management; business graphics. (Most students will opt to use an application package to develop their project.) Project and practical work is considered of paramount importance and students are encouraged throughout to focus on applications in their own area as the combination of information technology and their own discipline is the best portfolio they can carry out into the marketplace.

EXAMINATION AND ASSESSMENT (Table 1)

In line with the practical nature of the course, assessment has been made as flexible as possible. Coursework marks are collated in groups so that students can exercise a measure of internal compensation between subjects, eg Systems Analysis and Design; Data Processing; Business Practice. Similarly time-constrained examinations are also grouped, eg Data Processing and Database Management Systems. The project is given a heavy weighting, accounting for one third of the cumulative marks.

EXPERIENCES IN RUNNING THE COURSE

Overall the course has been voted a success by outgoing students and by their employers. Most diplomates have returned to their original career, and some have been successful in finding employment in the government agencies. A small percentage have made the transition directly into the computing profession. We would have reservations about the latter group and care and effort has had to be given to educating potential employers who tend not to differentiate between one IT qualification and another.

The balance we try to achieve is a comprise between addressing specialities for particular disciplines by covering a course wide enough for all and allowing flexibility for students to tailor the course to their own requirements.

As with any course of this nature the course team are continuously up-dating and re-evaluating course material and teaching methodologies in the light of new products and in the light of student feedback. We have had positive reaction to the interconnectivity of units. We try to encourage students to use the tools from one unit in any other relevant units and staff work closely on dual assessments and dual case exercises.

The units that have caused students the greatest difficulty appear to be programming units. We have given a great deal of thought to this issue. Many points of view have been expounded in the literature, from whose who advocate a rigorous and traditional programming unit to those who feel programming is inappropriate in this type of course (Ref 4).

Our original approach was based on algorithmic development using Program Design Notation (PDN) followed by Pascal. Students seemed to have great difficulty in accepting PDN as a vehicle and not a language in itself. Recognising that the aim of the programming unit is not to "make" programmers but to instill an understanding of the programming process, our approach now is to go from the concrete to the abstract. Semester 1 has been devoted to an in-depth intensive course in Turbo Pascal. Having mastered this students then study PDN and are able to recognise what they have done and how they can translate it to another language, ie the generality of the situation abstracted from the specifics of one language. In our experience non-cognate students need to achieve "hands-on" success to maintain their incoming enthusiasm. Getting a program working at an early stage fulfills some of their expectations and is an effective way of bolstering their confidence in coping with what is after all very foreign subject matter. Having mastered the mechanism there is a relatively easy move to acceptance of the underlying concepts.

The other major area I would draw your attention to is that of the project.

As I have already mentioned we attach a heavy weighting to this. We have always wanted to allow students maximum flexibility in their choice. In the early stages students were given a very wide brief. They could, for example, choose to present a project:-

1) developing a project using an application tool
2) evaluating a hardware and software solution
3) providing a feasibility study of a possible application area
4) programming a particular application

The learning experience is intensive over Semester 1 and 2 and in order to complete a substantial task a student has to first assimilate the material exposed. Therefore the course runs for a third Semester (11 calendar weeks).

Students make their choice and carry out preliminary work during Semester 2 but the real work of the project is undertaken after the terminal examination and over the summer period.

A list of suggested projects is circulated but students are actively encouraged to propose their own topic, again in line with their home discipline.

Three points worth noting are:

1) We now feel it important that all projects exhibit a degree of practical work.
2) The majority of students require close supervision in order to achieve a substantial exercise.
3) Particularly those students who undertake a project of their own choice need close supervision - otherwise they tend to give a dissertation on what they are most familiar with, ie their original area rather than on the computing element.

We are now operating very strict project guidelines tailored to the particular type of project. We have also decided to encourage students to use the second microcomputer workshop to carry out the practical part of their work. This provides closer liaison especially with those students who experience difficulty.

FUTURE DIRECTIONS

This paper has been an attempt to outline the progress with this course to date. It is not ideal and continues to evolve. We would like to develop the course towards more flexibility. We are considering a common core of material, ie six units all homogeneous but all intrinsically separate. This would allow us to consider single unit accreditation and to accommodate those who require a longer period of time or who only wish to acquire the qualification in part. We are also considering offering some degree of specialisation. This would vary depending on the intake, on resources and on interdisciplinary support here on campus. Suggested units are: Management Support Systems; Computer Aided Design; Computer Integrated Manufacture; International Databases and Data Communications. Again these options would allow us to accommodate the needs of part-time students already involved in the work-place and they in turn would enrich the course by their experience.

CONCLUSION

In conclusion we foresee an ongoing need for this type of course provided it is kept flexible and up-to-date. A great strength lies in the fact that it is not an on-going qualification or stepping stone and this releases us from the constraints normally present. We find it an exciting challenge addressing this area.

1 L D Rosen, D C Sears, Computer Phobia Behaviour Research Methods, Instruments and Computers (1987)
2 Dyck, Fenton, Black, Beyond Traditional Computer Literacy ACM (1987)
3 M G Bailey, Spreadsheets and Databases - Alternatives to Programming for Non-Computer Science Majors ACM (1987)

TECHNOLOGICAL PREPARATION OF SCHOOL ADMINISTRATORS IN THE UNITED STATES: PROGRAMS AND REQUIREMENTS

Dennis W. Spuck*, William C. Bozeman**

ABSTRACT

This study reports the results of a survey of faculty in more than 80 universities in the United States which have doctoral programs in educational administration. The survey collected information on the use of computers in administrative training programs and institutional requirements regarding computer-related courses in degree and certification programs.

From this current study, conclusions are drawn regarding the present status of technological training of school administrators in the United States and questions are raised regarding future directions and challenges of new information technologies for such preparation programs.

STUDY RESULTS

A national survey of computer emphasis in doctoral-level school administrator training programs in the United States was conducted, with over eighty institutions responding. Data were collected on institutional demographics, computer and laboratory facilities available, faculty perceptions of the adequacy of institutional support for computing, course offerings, course content, computer-related requirements, deparTment secretarial use of computing, and faculty sources of information regarding educational computing. Descriptive statistics were computed for all variables, with patterns of computer use and institutional support described.

Institution size ranged from 10% having fewer than 10,000 students and 24% having over 30,000 students. Schools of education averaged 85 FTE faculty, with 28% having under 50 faculty members and 7% having more than 150. Departments of educational administration averaged 9 FTE faculty, with 17% having over 10 faculty members.

Faculty responding ranged from over 20 years experience in teaching about computer concepts to virtually no experience, with over 50% having less than five years teaching experience. The majority of faculty indicated that they had not taken any graduate-level course work pertaining to computing. Additionally, the majority of faculty indicated that their departments had been offering computer-related courses for fewer than five years. Almost all (91%) faculty indicated that a computer laboratory was located in the school of education and that most faculty had a computer available in or near their office for their own work. However, those responding also indicated that most faculty did not make use of a computer on at least a weekly basis.

*University of Houston-Clear Lake
**University of Central Florida

Generally, computer availability and support was characterized as adequate, but not superior.

Those topics which faculty felt should be emphasized most in administrative computer applications courses were data-base management systems, spreadsheet/integrated software systems, and word processing. Those which were described as less essential were applications in computer-assisted instruction, computer-managed instruction and graphics packages. Only 34% of the respondents indicated that mainframe applications were included in the course.

Most degree and certification programs do not require that a computer course be included, but most do permit it to be credited as an option.

Many of the faculty reported that special applications were being developed at their institutions which could be used to train educational administrators about computer applications or about other education-related subject matter, including applications of CD-ROM, voice recognition/ synthesis, and computer-based simulations. Results of this survey suggest that basic computer hardware has become available within schools of education to be used in the training of future school administrators and to support faculty needs, but that software and training support is not adequate. The current level of faculty sophistication about computer use is limited, but responding faculty seem to recognize that more in-depth training is desirable. The trend toward including computer applications has begun in earnest only in the past five years, but this trend suggests an increasing level of emphasis in this area. Innovative research and development projects being conducted by education faculty underscore this trend and point to some exciting new training alternatives.

Technical Preparation of School Administrators in the US: Course Structure and Content

Bozeman, W.C.* and Spuck, D.W.**

ABSTRACT

This study reports the results of a recent study and analysis of courses related to computer applications in 76 U.S. university educational administration programs. The purposes of the study include the determination of (a) the extent to which curricula include the technology component; (b) perceived leaders in the field of administrative computing; (c) sources of information about computing; (d) the primary professional organizations related to computing; and (e) instructor preparation for the field. Course outlines and syllabi were also reviewed. Results of the study suggest that this area is not yet a well-defined domain in most educational administration programs, and that there is a sparsity of administration professors with backgrounds in computing.

INTRODUCTION

Any organization, certainly including the school or unit within the school, requires information to function on a regular basis. The processing of data into some form of useful management information is critical to the successful operation of the school. This conversion of data to useful management information (data processing), and the preparation of school administrators in this area, is the subject of this paper. This paper reports the synthesis of surveys of 76 U.S. colleges and universities regarding the content of their respective programs of study. Secondly, a set of recommendations for the content and structure of such programs are presented.

Administrative data processing applications were among the first uses of computers in school districts, preceeding instructional applications. By the late 1950s, most large school districts and colleges were using mainframe systems for various administrative purposes. Today, almost all educational organizations routinely use computers of all sizes for day-to-day operation as well as instruction. Given below are common areas of computer applications in educational administration:

---

*Professor, University of Central Florida, Orlando, FL 32816 USA
**Associate Dean, University of Houston, Clearlake, TX 77058 USA

Personnel:

Payroll (calculations, withholdings, check writing)
Employee records
Certification and license verification
Faculty and staff assignments
Government reports

Financial:

Budgeting
Financial accounting, auditing, and reporting
Accounts payable and receivable
Internal ledgers
Purchasing and distribution
Capital outlay analysis and planning
Attendance accounting
Inventory control
Investment planning
Auxiliary services, transportation, and food services

Student Applications:

Academic records -- grades and transcripts
Attendance -- daily, class, and summary
Guidance and counseling
Demographic data
Grade reporting and analysis
Instructional management
Test scoring and reporting

Office Automation

Word processing
Filing systems
Management information systems
Electronic spreadsheets
Desktop publishing
Electronic mail
Local area networks

Planning, Research, and Evaluation

Statistical analysis
Attendance zoning and assignment
Project planning and control
Enrollment forecasting
Environmental scanning
Bus routing

While this listing is not complete, it does provide examples of topics which are both illustrative of administrative computing, and possible topics for inclusion in the program curriculum. State and regional needs will dictate certain unique components.

SURVEY RESULTS

Survey analysis revealed that only a few institutions have courses, offered in the immediate department or program of educational administration. Many programs utilize courses offered by other departments such media or instructional technology. This is consistent with the survey reports that there are few individuals considered to be leading scholars in the field, and an absence of texts and other literature to support such courses. Additionally, there is little evidence that computing has been integrated, in a significant way, into the content of other areas or courses such as finance, business management, law, or personnel.

Course content, as demonstrated by outlines and syllabi, appears to include introductions to popular computing topics: word processing, spreadsheets, filing systems, hardware and software evaluation and selection, CAI/CBE, and elementary programming. In a sense, most courses might be accurately described as general computer literacy classes.

RECOMMENDATIONS

Comments from many respondents point to a persistent problem: the general lack of knowledge of computing when school administrators come to a course related to administrative computing. Therefore, it is difficult, if not impossible to structure a class consistent with most graduate school expectations when participants lack the requisite knowledge or experience. This situation will likely improve in the not-too-distant future as colleges of education improve the technology component in pre-service teacher education programs. In the interim, it is recommended that programs of educational administration set clear entry requirements for the administrative computing class. The requirements should, at a minimum, include general computer literacy.

Related to the the above comment is the recommendation that programs of educational administration develop, using the talents of persons outside the program area if necessary, a course or courses specifically designed for school administrators. A course taught in the instructional technology or foundations area will not likely address topics such as those outlined above. Topics should be addressed a level consistent with graduate studies, and not at a level of introductory computer literacy.

SCHOOL AUTOMATION: A PARADIGM FOR ANALYSIS

J.C. Honeyman *, D.S. Honeyman **

ABSTRACT

This paper describes a paradigm for determining the functional requirements for effective computerization of education. The educational environment is richer in functions than is the business or office environment and needs a holistic approach to system specification. Such an approach should produce plans which incorporate the requirements of administrators, teachers, students, and parents. Frequently, the functions of each group are developed separately, resulting in the acquisition of a heterogeneous mix of equipment that is difficult to integrate and instructionally ineffective. The systems methodology described in this paper promotes communication between all educational stakeholders and the systems analyst in the design of effective school automation.

INTRODUCTION

The use of systems analysis has proven effective when dealing with the design of computer systems for business and industry, but has not yet been adequately applied to the complex requirements of school systems. Data processing capabilities for schools exist in several forms including attendance monitoring, budgeting, scheduling, computer aided instruction (CAI) and tools to analyze students' learning and career aptitudes. However, a comprehensive methodology for integrating computers throughout the school environment is not commonly employed. The problem is not unique to school systems, but given the constraints of the school budget and the diverse and conflicting requirements of a school system, the problem is more complex and can negatively effect the students in the school. Fully understanding and stating the problem is the first step in its solution.

THE PROBLEM

The typical school system will "automate" the administrative operations and the instructional functions without a plan for integrating these two separate and usually very different systems. When microcomputers are being used to implement automation, at least two manufacturers or system types with different software and growth committments are usually considered - the IBM compatible family for administration and the APPLE family for instruction.

The historical pattern of developing computer automation within an organization has been described by Zisman (ref 1) and follows Nolan's growth curve (see figure 1). In the initial phase of automation, there is a perception of a need for computers and they are introduced generally with little planning and usually to serve the need of one person or a single function. Once the computer is in place and individuals become comfortable with the equipment, a period of rapid expansion takes place. Still

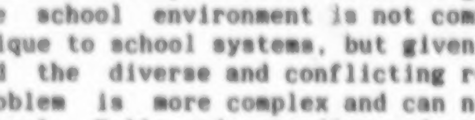


FIGURE 1: NOLAN'S GROWTH CURVE OF AUTOMATION

---

*Drexel Univ., Philadelphia, Pa., **Lehigh Univ., Bethlehem, Pa without planning. this phase usually involves the purchase of more computers. more software. with little consideration of integration of the parts into a system-wide solution of problems. This is followed by the formalization phase where the need to integrate functions is realized and an attempt is made to turn chaos into order. Once the organization has successfully integrated its computers and functions a period of maturity is entered with planned growth and mature computer use. One goal of systems analysis is to avoid or manage the rapid expansion phase and to use a systems approach to incorporating computers in an organization. At this point the systems analyst's job may be seen as either planning and design or as recovery and redesign of systems which have experienced uncontrolled growth. The characteristics of organizations in this expansion phase are described below:

- A heterogeneous mix of equipment exists with no personnel who can operate all of the systems. This results in a system or systems that are not used at all.
- There is a heterogeneous mix of equipment which is difficult to integrate. uses incompatible software and may require multiple vendors for service.
- Unplanned often spurious software purchases result in higher costs and low equipment use.
- A high level of frustration is observed among users who perceive that the software or systems do not work the way they should.

In the educational setting. this problem of growth is complicated by the fact that the growth curve tends to split with administrative functions expanding in one direction and instructional functions expanding in another. In many cases. the administrative side of the system has reached a point of maturity. but the instructional side is still in rapid expansion or is deadlocked. mired in confusion.

A CONCEPTUAL FRAMEWORK FOR ANALYSIS

A model for schools needs to be created to assist the analyst attempting to design computer support for a school system. Currently. analysts tend to use one of the following conceptual approaches to designing computer systems for an organization: the communications approach. the information and resource management approach. functional analysis approach. or decision support approach. The communications approach treats integration and automation as a communication problem between sections of the system (ref 2). The analyst using this approach will base his or her design on networking of computers within the organization. The principal focus will be on establishing communications paths that are efficient and effective. and will attempt to optimize these communication paths. The analyst using an information and resource management approach will try to optimize the use of information in the organization and will focus on storage. flow. and retrieval of useful information (ref 3). The use of the functional approach to system design identifies and analyzes the individual often discrete functions performed in an organization in as effort to increase efficiency in performance of each function (ref 4). while the decision support approach attempts to provide support to management in non-routine tasks which are important to the efficient operation of the organization (ref 5). The school, with it's rich and complex information and functional requirements, cannot be analyzed using only one approach. The different focuses of the participants in the school setting indicates the need to involve the users in the development of the system. A conceptual model is needed which reflects the requirements of both the administrative and the instructional functions of school systems.

The conceptual school model illustrated in figure 2, is based on Tapscott's model for organizational analysis (ref 6). The stakeholders, those persons with an interest in the system, are the primary drivers of the analysis and design process. In the educational setting, the stakeholders are individual members of the educational community, students, and parents. Each stakeholder or representative would have his/her own set of goals and objectives and each would be a part of the overall mission of the organization. In the top part of the framework of the model these separate goals for each stakeholder and the appropriate "key result areas" by which the achievement of the goals is measured are identified. The model adds a "front end" to the traditional systems analysis and design lifecycle and provides the analyst with a set of measurable objectives for the system. Examples of stakeholder concerns for an instructionally effective school might include the three goals below with their attendant key result areas.

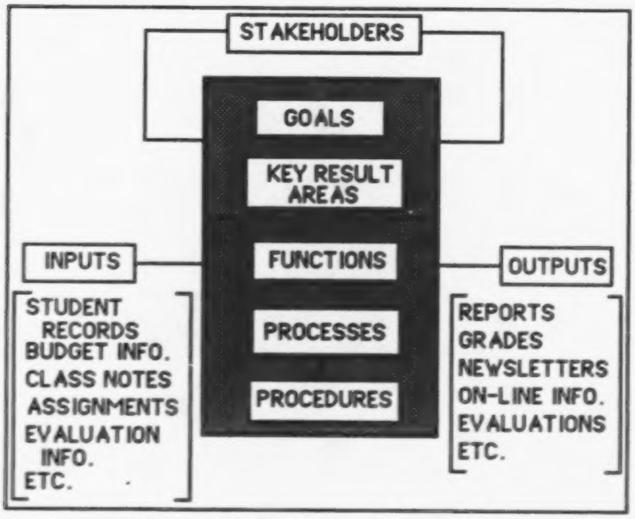


FIGURE 2: CONCEPTUAL MODEL FOR ANALYSIS

GOAL: Frequent monitoring and reporting of student progress
  KEY RESULT AREAS:
    Teachers will have access to student progress on a daily basis
    Teachers will have problem diagnosis and remedical suggestions available upon request
    Parents will be informed on a weekly basis if problems exist
GOAL: Student attainment of essential skills
  KEY RESULT AREAS:
    All students will be taught essentials of computer usage
    The computer will be incorporated into all fields of study
GOAL: The school will be a partnership with parents and community
  KEY RESULT AREAS:
    Parents will have on-line access to student's progress reports
    Newsletters reporting school and community functions will be distributed on a regular basis

In the lower part of the model, functions, processes and procedures within the organization are modeled hierarchically with increasingly greater refinement. The analyst must use a combination of the standard analysis approaches noted above to design a system matching the goals and objectives identified by the stakeholders. The communication approach should be used to specify the on line requirements for users, to provide direct communication between the classroom progress records and the student information system, and to provide messages or electronic mail between teachers, administrators, and other personnel. Functional analysis of processes and procedures (generally administrative) should be used to ensure efficiency of the system. Information resource analysis may suggest more efficient data storage and easier retrieval and presentation of relevant information. Subsections of student records can be made available to teachers, students, and parents based on access rights to those records. The decision support approach should be used to create administrative models for decision making on salaries and budget, while teachers should be given the capability to develop simulations for classroom investigation and for diagnosis and remediation of learning problems.

Within this conceptual framework, the integration of a school's computers may be viewed as a process of identification of the intersection of the functions of the various systems and communication between the them to support the movement and the use of data. If a teacher is to be effective in the classroom, relevant data on students must be available in the classroom setting. There is a natural intersection of student records and attendance data, an intersection of administration and instruction. If CAI software provides progress reports, the computers on which CAI exists and the computers on which administrative records exist must communicate with each other. Computer networks are being designed to facilitate that communication, but successful development requires planning.

RECOMMENDED STEPS TOWARD INTEGRATION

Many school systems have a substantial capital investment in computer equipment. To protect this investment they must initiate a systems analysis approach to the reallocation of present equipment and to planning for future purchases. There must be a committment on the part of the system stakeholders to formalize the use of the computer and to the integration of previously independent parts to provide efficient and effective use of the computer in the school setting. A systems analyst familiar with model presented above should be consulted to help with the requirements, specification and design of the system. While long range planning may be impossible with rapid technological changes, adequate planning in two year increments should allow integration of existing equipment with expansion as new products are introduced.

REFERENCES

1. M.D. Zisman, Sloan Management Review 19, 1-16, 1978.
2. K.W. Deutch, Pub. Op. Quar., 16, 356-380, 1952.
3. J. Martin, Application Development Without Programmers (Savant Research Studies, England, 1981)
4. J. Martin, Recommended Standards for Analysts and Programmers (Prentice-Hall, New Jersey, 1987).
5. P.G. Keen and M.S.S. Morton, Decision Support Systems: An Organizational Perspective (Addison-Wesley, Mass. 1978).
6. D. Tapscott, Office Automation: A User-Driven Method (Plenum Press, New York, 1982)

IDENTIFYING COMPUTING PRIORITIES FOR EDUCATIONAL POLICY DEVELOPMENT: CONTRASTING UNCONSTRAINED AND CONSTRAINED PERCEPTIONS

Brent Edward Wholeben†

ABSTRACT

Educational administrators responsible for policy development in the area of educational computing can expect to face several important tasks relative to component identification and priority resolution. Computing policy priorities will be demanded differentially for: (a) primary, elementary, middle, and high schools; (b) administrators, support services staff, teaching faculty, and school boards representing parents; (c) humanities, social science, and natural science faculties; (d) diversity and longitudinality of professional service to education, and (e) type and amount of post-baccalaureate training. Furthermore, computing priorities will alter, predictably, when constraints are applied to such areas as instructional focus, resource availability, and diversity of participants. The basis for identifying these priorities, contrasting demographic sub-groups in each of the artifically-contrived, unconstrained and constrained settings, is a simple survey instrument of 52 items, administered individually in multiple-response format.

INTRODUCTION

Issues of ethics and equity are associated with the use of administrative and instructional data processing and are a growing concern to professional educators. These issues may identify several areas of interest in education, including: curriculum, access, privacy and confidentiality, teacher, student, community, organizational focus, software, and hardware. For 1985-87, a select International Committee for Computing Ethics, under the sponsorship of the International Council for Computer Education located at the University of Oregon, studied the underlying components of computing ethics and equity. Initially involving several hundred specific areas of concern, a collection of 52 declarative statements were formulated to represent (hypothetically) a mutually exclusive and collectively exhaustive system of ethical and equitable guidelines for the professional educator.

METHODOLOGY

Instrumentation

The data collection instrument is self-disclosing by respondent and comprises a single sheet (two sides). All ICCE items are random ordered, stated in declarative form as an objective of educational computing policy, and with individual schema for the respondent to report their responses to each item. Three types of data are suggested: (1) general respondent demographics, including discipline background and grade-level experience, extent of computer-related knowledge, and extent of post-baccalaureate training; (2) selection of 20 initial policy priorities from among the total 52 components of the ICCE list; and lastly,

---

†Department of Educational Leadership and Counseling, College of Education, University of Texas at El Paso, El Paso TX 79968 USA

(3) identification of which initial priorities change when environmental conditions present constraints upon initially perceived needs (viz., reduction of the 20 initial components to 10 final priority items.

Procedure

Respondents will supply three types of data in addition to completing the demographics section(s). First, to establish an initial priority ordering, each respondent will select 20 of the available 52 statements as perceived requirements for a comprehensive policy on computing ethics and equity. Second, to simulate an artificial environment of imposed general (viz. undefined) constraints, each respondent will select the most important 10 of these initial 20 components. Lastly, to differentiate relative worth among the top-10 choices, each respondent will rank-order (from 1-10, without ties) these final 10 selections.

Pilot

The instrument has been successfully piloted with a stratified random sample of K-12 professional educators (n=797), and a non-probability sample of equivalently-trained (baccalaureate) non-educators (n=56) who served as a control for profession-related bias in policy development.

RATIONALE

The procedure recommended is a forced-choice, dichotomous item survey which presents a total listing of all possible issues of interest to the respondent, requiring only that the respondent select those issues of personal interest by checking the item itself. Such an approach is superior to Likert-type response formats or similar continuum-based rating scales which introduce (a) bias based upon interpretation of differential scale levels and (b) tedium of response when a large number of items are to be reviewed and evaluated.

Initially selecting 20 of the available 52 items highlights the interest of each repondent without restricting unnecessarily the quantity of selection. Reducing the 20 to a final 10 not only allows the respondent to make a final selection from a lesser quantity (20) of items but also provides a more constrained environment for the respondent to signify which 10 of the 52 items are of superordinate priority.

ANALYSIS

Four levels of specific statistical analysis are recommended initially: descriptive summary, correlation, contingency contrast, and demographic comparisons. Logistic regression and discriminant function analysis may be deployed if sample size allows.

Descriptive summary

The distributions of raw frequency and percent of cases for the selection of top-20 and top-10 policy components must be delineated by demographic group and analyzed for degree of normality. Non-normal distributions can be forced-normalized utilizing common or naperian logarithm, square root, or exponential transformations as appropriate. Acceptable normality limits are ±.5 skewness and ±1.0 kurtosis.

Correlation
Pearson product-moment correlation coefficients can be computed to analyze the relationships between top-20 and top-10 selection levels, and top-20 to top-10 changes across respondent groups. Partial coefficients are necessary only when comparing educator and control group changes in frequency (from top-20 to top-10). Original top-20 selection levels can be introduced as covariates for this comparison in order to compute the degree of relationship between-groups for selection-frequency changes regardless of initial priority differences. It is suggested that, due to distributional qualities, all parametric correlations be re-evaluated with a non-parametric approach (e.g. Kendall-tau).

Contingency contrast
Simple contingency (chi-squared) analysis is the priority technique for analyzing this type of data, and is used to evaluate bivariate nominal and ordinal relationships between selection preferences and respondent demographics. Changes in significance levels for top-20 and top-10 items signify the change in attitudes simulated by artificial constraints. Multiple categorical analyses may be performed using loglinear analysis.

Demographic comparison
A final technique employs a Kruskal-Wallis (oneway analysis of variance based upon associated ranks) procedure to evaluate the distributions of frequencies and percents based upon select demographics of respondents.

REPORTING FORMATS

While conventional procedures for displaying the results of descriptive summaries and correlational asssessments suffice, a novel approach to reporting the results of the contingency contrasts is recommended. Three individual displays are required: (1) unconstrained contrasts of policy priorities, (2) constrained contrasts of priorities, and (3) profiles.

Unconstrained contrasts
Significant ($\leq$.05**) and marginal ($\leq$.10*) chi-squared contrasts between top-20 selection v. non-selection and demographic levels can be reported as displayed in Figure 1a.

Constrained contrasts
Significant ($\leq$.05**) and marginal ($\leq$.10*) chi-squared contrasts between top-10 selection v. non-selection and demographic levels can be reported in a manner which incorporates constrained contrast results with a summary of the original unconstrained contrasts as displayed in Figure 1b.

Profile summary
Any specific demographic level might be summarized by, first, executing a contingency analysis comparing that level against all others, and second, summarizing the results as displayed in Figure 1c.

Note: Data entry formats and statistical program codes are available directly from the author upon written request.

Figure 1. Sample reporting formats for contingency analyses.

Figure 1a. Unconstrained contrasts.

```
high school
 more priority
   ** DEPT/SUBJ AREA COMPU USE EQUITY (curricular equity)
 less priority
   ** PRNT INVL IN COMPU STRATEG PLNG (community participatory planning)
elementary school
 more priority
   *  USE EQUITY VS STUD STATUS/NEED  (student user equity)
 less priority
   ** DEPT/SUBJ AREA COMPU USE EQUITY (curricular equity)
```

Figure 1b. Constrained contrasts.

```
high school
 more priority
  (sustained)
   ** DEPT/SUBJ AREA COMPU USE EQUITY (curricular equity)
  (emergent)  None
 less priority
  (sustained)
   ** USE EQUITY VS STUD STATUS/NEED  (student user equity)
  (emergent)
   ** INTEG COMPU USE AT ALL CURR LEV (cross-curricular integration)
elementary school
 more priority
  (sustained)
   *  PARTIC IN COMPU USE GOAL SELEC  (teacher participatory planning)
  (emergent)
   ** INTEG COMPU USE AT ALL CURR LEV (cross-curricular integration)
 less priority
  (sustained)
   ** DEPT/SUBJ AREA COMPU USE EQUITY (curricular equity)
  (emergent)
   ** EXAM ISSUE OF COMPU USE ETHICS  (situational assessment)
```

Figure 1c. Profile summary.

```
unconstrained
 more priority
   *  CPYRGT STND IN SCH/COM INTERACT (copyright protection)
 less priority
   ** TCH/ADM PARTIC IN EQUIP SELEC   (hardware participatory selection)
constrained
 more priority
  (sustained)  None
  (emergent)
   ** EVAL CONTROVERS S/W OR METH USE (evaluating controversial use)
 less priority
  (sustained)
   ** TCH/ADM PARTIC IN EQUIP SELEC   (hardware participatory selection)
  (emergent)
   ** CURRIC MATER VS DIFF LRNG STYLE (learning style equity)
```

EDUCATIONAL COMPUTING PRIORITIES FOR POLICY DEVELOPMENT: A SYSTEMIC STUDY OF PERCEPTIONS UNDER ARTIFICIAL CONSTRAINTS

Brent Edward Wholeben†

ABSTRACT

A study of N=853 educators and non-educators demonstrated that officers responsible for policy development in educational computing can expect to face several important tasks relative to component identification and priority resolution. Middle school perceptions of policy priorities were seldom distinct from elementary and secondary colleagues. The linearity of significant differences contrasting elementary and high school perceptions suggested a strong relationship between level of graded instruction and the differential value of policy initiatives. Social science educators' perceptions of policy priorities were significantly distinct from those of colleagues in the natural sciences and humanities. Unexplained variance between educators and non-educators, with constraints applied, suggested that different strategic objectives and motivations for policy development exist between professional educators and communities served.

INTRODUCTION

The International Council for Computers in Education released in 1987 the Code of Ethical Conduct for Computer-Using Educators, a comprehensive statement on ethics and equity in educational computing comprising 52 separate guidelines related to curriculum, access, privacy and confidentiality, teacher, student, community, organization, software, and hardware. Would these guidelines be accepted by the education profession? Which issues would be considered sine qua non requirements? Which statements might be relatively unstable during periods of constraint? What differences might be contrasted between educators and non-educators in terms of overall strategy for implementing such a global policy?

This paper presents the results from an initial stratified random survey of K-12 professional educators (n=797) and a control group of non-educators with equivalent baccalaureate-level backgrounds (n=56). The data collection instrument was self-disclosing by respondent. First, to establish an initial priority ordering, each respondent selected 20 of the available 52 statements as perceived requirements for a comprehensive policy on computing ethics and equity. Second, to simulate an artificial environment of imposed general (viz. undefined) constraints, each respondent selected the top-10 of these initial 20 components.

DIFFERENTIATION BY BACKGROUND

Educational administrators responsible for policy development in the area of educational computing can expect to face several important tasks relative to component identification and priority resolution. Differing

---

†Department of Educational Leadership and Counseling, College of Education, University of Texas at El Paso, El Paso TX 79968 USA

perceptions of priority based upon individual backgrounds will exist, not necessarily in general goal focus, but significantly in terms of specific policy objective.

Grade-level experience (Stave 1, Table 1)
While middle school perceptions of policy priorities did not differ, in most cases, from those of their elementary and secondary colleagues, the linearity of difference between elementary and high school needs suggests a strong relationship between level of graded instruction and the value of certain policy initiatives. Middle school educators will demand mid-range priorities for educational policy components viewed at opposite ends of the continuum by elementary and high school educators. Contrasting viewpoints related to student equity in computer-use allocation based upon special needs, learning styles, and curricular importance will demand mediation. The need (or desire) for participatory planning and evaluation will undergo severe transformation in the middle grades, as will the importance of controlling donor preferences over gifts, and issues related to copyright protection of both software and printed materials. Instructional computing priorities for the middle school will be contrastingly different than either elementary or high school needs.

Curricular discipline training (Stave 1, Table 1)
Between-group contrasts indicated that humanities' educators were more likely to agree on high-priority components while their social science and natural science counterparts were more likely to agree on low-priorities. Social science educators will demand higher priorities for accountability based upon specific criteria, effective and efficient management of available computer resources, and literacy development across all user-parties. Contrasting viewpoints related to training limited only to teachers as well as a possibly defined intention that administrators take significant leadership in determining computer-related goals in an expedient fashion may well demand mediation. The need (or desire) for major focus upon content of action and the product by the social science educator, contrasted to the opposite view of process and facilitation by natural science and humanities' educators indicate a potentially perplexing dichotomy for the administrator when attempting to satisfy both of these divergent demands.

Professionalism preparation (Stave 2, Table 1)
Primary requirements for unconstrained policy development in the area of educational computing differ significantly in general focus between educator and non-educator respondents. When artificial constraints were introduced, and the range of respondent choices restricted, educators generally modified their initial policy requirements, while non-educators mediated initial priority levels, shifted priorities, and diversified their constrained demands. Consistent, high-priority policy interests for educators were generally viewed as "negotiable" for non-educators when constraints were present. Concomitantly, policy interests deemed negotiable by educators were generally viewed as consistent, low-priority for non-educators. Both groups will require strong guidance regarding the importance of strategic planning and program validation.

Table 1. Significant Priority Differences (p_.05) Based Upon Teaching Experience, Curricular Background, and Individual Profession

	Unconstrained Selection		Constrained Selection		Summary Post-Constraints	
	Experience	Curriculum	Experience	Curriculum	Educators	Non-Educators
DEVL/COM CRIT RE EDUC H/W USES (criterion development)		SS+ NS-				
TCHR TRNG FOR INTEGRD COMP USE (teacher training for use and change)		SS- HU+		SS- HU+	PE+	
PARTIC IN COMPU USE GOAL SELEC (teacher participatory planning)	EL+	SS- HU+	MD-	SS- HU+ NS-		
PARTIC IN EVAL COMPU USE RESLT (teacher participatory evaluation)		HU+ NS-		HU+ NS-		
PLNG FOR EQU COMPU RESOURC MGT (resource management)				SS+ NS-		
COMPU LITRCY FOR TCHR AND STUD (comprehensive user literacy)				SS+ HU-		
LRNG ENVIRS DESIR FOR COMPU USE (learning environment selection)	HS+					
DEPT/SUBJ AREA COMPU USE EQUITY (curricular equity)	EL- HS+		EL- HS+			
TCH SUBORDS DATA USE RESPONSIB (staff inservice development)	EL- HS+					NE+
DSCOUR/REFUS PRINT MATER COPY (printed documentation duplication)	EL- HS+					
PRNT INVL IN COMPU STRATEG PLNG (community participatory planning)	HS-					
ANAL S/W GENDER/ETHNIC EQUITY (representative equity)	HS-					
TCH/ADM PARTIC IN EQUIP SELEC (hardware participatory selection)	MD-		EL+			
CURRIC MATER VS DIFF LRNG STYLE (learning style equity)	EL+		EL+		PE+	
PRNT INVL IN COMPU STRATEG PLNG (community participatory planning)	EL+					

(Note: Table 1 continued on overleaf)

(Table 1 continued)

Table 1 (continued)

	Unconstrained Selection		Constrained Selection		Summary Post-Constraints	
	Experience	Curriculum	Experience	Curriculum	Educators	Non-Educators
ANAL S/W GENDER/ETHNIC EQUITY (representative equity)	EL+					
USE EQUITY VS STUD STATUS/NEED (student user equity)			EL+ HS+			
INTEG COMPU USE AT ALL CURR LEV (cross-curricular integration)			EL+ HS-			
EXAM ISSUE OF COMPU USE ETHICS (situational assessment)			EL- MD+			NE+
TRNG APPROP TO CLSRM COMPU USE (pre-utilization training)					PE+	
TM RELEAS FOR TRNG RE PROJ USE (release time for training)					PE+	
TCH/ADM PARTIC IN EQUIP SELECT (participatory selection)					PE+	
EVAL S/W QUAL FOR CLASSRM USER (quality evaluation)					PE+	
CURR USE REFLCT FUTR STUD NEED (relevancy in vocational orientation)						NE+
TCHG STUD ETHICS OF COMPU USES (specific instruction in ethics)						NE+
INC UNDERST OF EDUC COMPU GOAL (community awareness)						NE+
DISCOUR/REFUS UNAUTHOR DUPLICT (program duplication)						NE+
PLNG COMPU INTEG VS FUTR STRAT (strategic alternatives planning)						NE+
EVAL SIMUL MODL FOR SOCIET DEC (ethics/equity bases in planning)						NE+

EL (elementary school)
MD (middle school)
HS (high school)

SS (social sciences)
HU (humanities)
NS (natural sciences)

PE (educator)
NE (non-educator)

+ (high)
- (low)

ROBOTICS: HUMAN RESOURCE IMPLICATIONS FOR INDUSTRIAL AMERICA

Ivan Louis Cotman* - Presenter.
H. Allan Hunt°, Timothy L. Hunt°

INTRODUCTION

One major aspect of the evolution of technology in the United States addresses the application of industrial robots to major industrial or automotive processes. What are the implications of the emerging field of robotics on the education of industrial workers relative to job displacement and what training skills are needed in response to the robotic explosion?

Robots are coming, but they will disperse fewer workers than origianlly thought. However, by 1990, some 13,500 to 24,000 jobs in Michigan will be lost to robotics.

These startling findings and conclusions come from a recent study entitled "Robotics: Human Resource Implications for Michigan" and form the basis for this abstract. Commissioned by the Michigan Occupational Information Coordinating Committee (MOICC), a federally funded interagency program responsible for the improvement of occupational information, the study was conducted by The W.E. Upjohn Institute for Employment Research. The principal researchers and authors of this study are H. Allan Hunt and Timothy L. Hunt.

The paper to be delivered covers the findings and conclusions with recommendations for education and training of tomorrow's industrial workers. The paper will detail the following data from the study:

--By 1990, the U.S. robot population is expected to jump to 50,000 to 100,000 units with approximately 7,000 to 12,000 robots in use in Michigan.

--Generally, current workers are not expected to be thrown out of work by robots with reductions in force being achieved through attrition.

--The auto industry, the biggest user of robots, will lose 75 percent of all jobs lost to industrial robots in Michigan.

--The study projects a 30 to 40 percent annual growth rate for the robotics industry. Such expansion could be compromised by a shortage of electrical, industrial and mechanical engineers.

--If training of technicians is not monitored carefully, an oversupply may quickly emerge. Excluding the auto industry, only 750 to 2,700 robotics technicians will be needed in Michigan by 1990.

--In spite of all the scientific and media attention robotics has received, there was very little good information available to counsel

*Associate Superintendent for Rehabilitation and Disability Determination, Michigan Department of Education, Lansing, Michigan, U.S.A.
°W.E. Upjohn Institute for Employment Research, Kalamazoo, Michigan, U.S.A.

jobseekers and students and to advise training program administrators and planners.

This study is focused on the human resource implications of the robotics "revolution," but before proceeding it is necessary to put the "revolution" into some perspective. There are precious little hard data about industrial robots today. Most of the public awareness of robots has been shaped by the hyperbole in the popular press in the last few years. For example, Newsweek, has highlighted the jobs of the future, including an estimate of employment in industrial robot production in 1990 of 800,000 workers. This figure would surpass current U.S. employment in the motor vehicle industry. The intense media attention on robotics in the past few years or so may have seriously confused the issues.

First, the use of the word "revolution" is inappropriate when dealing with any manufacturing process technology. Capital goods for production have long lives and are not scrapped immediately when something better comes along. Numerically controlled machine tools, usually regarded as the most closely related capital equipment to robots, expanded at a growth rate of only 12 percent for the most recent ten-year period. After 25 years, only 3 to 4 percent of all metalcutting machine tools are numerically controlled. Even digital computers, widely heralded as the most significant technological innovation of the 1960s and 1970s, expanded at a growth rate of only 25 percent, yet many are implicitly assuming much higher growth rates for industrial robots. In terms of actual application, all process technology changes are evolutionary rather than revolutionary because there are physical, financial and human constraints on the rate of change of process technology.

Second, the fear of massive unemployment caused by the introduction of industrial machinery appears to be unfounded. Such fears began with the dawn of the industrial era in the 1700s. They are particularly acute during major recessions. For example, the "automation" problem was of urgent national concern in the early 1960s after a halting recovery from the sharp recession of 1958-59.

Third, there appears to be a fundamental lack of understanding that the association of technological change, economic growth, and job displacement is not just a coincidence; they are intertwined and inseparable. That is not to imply that adoption of new technologies necessarily insures economic growth, or that displaced workers will always find new jobs.

BASICS OF ROBOTS

A robot is a reprogrammable, multifunctional manipulator. A robot can perform the same task on identical workpieces repetitively; it can perform multiple tasks on the same workpiece; or it can be reprogrammed to perform entirely new tasks.

The Robot Institute of America (RIA), the trade association of robot manufacturers and corporate users, reports that there were approximately 4,700 robots in the U.S. in 1981. By the end of 1982, approximately 6,800 to 7,000 robots were operating in U.S. factories. When the study was completed in 1983, employment in U.S. robot manufacturing was roughly 2,000 workers nationwide. This should make it clear that most of the employment impacts to be discussed are in the future. The growth in application of industrial robots and the employment implications of that growth both have to be projected because of the very limited empirical base to date.

Unlike R2D2 and C3PO of the movie Star Wars, robots of today are essentially "dumb machines." They are generally immobile, they usually lack any visual or tactile sensory perception, and therefore cannot adapt to their environment in any way. Generally they are no faster than human workers, but they are tireless. In layman's terms that means a robot can reproduce a specific range of motions for which it has been programmed, but it does not know if it is really holding the part it is supposed to be or if the work was done correctly. Although the trade literature makes much of the reprogrammability of robots, relatively few robots today are truly reprogrammed.

GROSS CUMULATIVE DISPLACEMENT EFFECTS BY 1990

Before discussing the displacement effects of robots, it is important to insure that the meaning of the term "displacement" is clear. Displacement is used to refer to the elimination of particular jobs, not to the layoff of individual workers. It clearly is possible that the displacement of a particular job by a robot might lead to the layoff of the occupant of that job, but it is not necessary. Layoff refers to the involuntary separation of the worker from the firm; displacement refers to the elimination of the job itself without an assumption as to whether the worker in that job is separated from the firm either voluntarily or involuntarily.

Utilizing the Michigan robot forecast by industry, and the assumption of a gross displacement rate of two jobs per robot, estimates of gross job displacement are derived. It is estimated that robots in Michigan will eliminate between 13,500 and 24,000 jobs by 1990. Between 10,500 and 18,000 of these will be in the auto industry, while 3,000 to 6,000 non-auto jobs will also be eliminated. In relative terms, over 75 percent of the job losses in Michigan are expected to be in the auto industry.

The conclusion of the job displacement estimates is that while job displacement due to robots will not be a general problem before 1990, there will clearly be particular areas that will be significantly affected. Chief among these will be the painting and welding jobs for which today's robots are so well adapted. Lesser impacts will be apparent on metalworking machine operatives and assemblers.

It is not believed that this job displacement will lead to significant job loss among the currently employed, however. Even in the auto industry, voluntary turnover rates historically have been sufficient to handle the reduction in force that might be required. In addition, the new General Motors-United Auto Workers contract seems to provide adequate job security assurances, and the retraining commitment necessary to back them up. Thus it is not expected any substantial number of auto workers will be thrown out of work due to the application of robots. Any unemployment impact is likely to be felt by the labor market entrants who will find more and more factory gates closed to the new employee. Therefore, if there is an increase in unemployment as a result of the spread of robotics technology, it is feared the burden will fall on the less experienced, less well educated part of our labor force.

JOB CREATION IN MICHIGAN BY 1990

Turning attention to the job creation issue, it is interesting to first consider the current occupational profile of U.S. robot manufacturers. For comparative purposes, the occupational structure of the motor vehicle and equipment industry, all manufacturing, and all industries are also presented. The occupational profiles have been aggregated into broad occupational groupings primarily to facilitate comparison and to highlight the technical labor input component.

By 1990 the direct creation of from 5,000 to 18,000 jobs in Michigan will be in four broad areas: robot manufacturing, direct suppliers to robot manufacturers, robot systems engineering, and corporate robot users (autos and all other manufacturing). The jobs in corporate robot users identify maintenance requirements for robots, while the jobs in robot systems engineering identify the applications engineering requirements for robot systems, without regard to industry or employment.

While it would be feasible to increase the supply of engineers by this amount, there is already a clear shortage of electrical engineers and a possible current shortage of industrial engineers. In addition, the Michigan economy faces the challenge of other likely engineering demand increases, as well as the historical instability of engineering enrollments. Thus it is quite likely that a shortage of engineers could compromise the expansion of robotics technology. It is especially disturbing, therefore, that Michigan's share of the production of engineering graduates has been declining over the last two decades.

The most remarkable thing about the job displacement and job creation impacts of industrial robots is the skill-twist that emerges so clearly when the jobs eliminated are compared to the jobs created. The jobs eliminated are semi-skilled or unskilled, while the jobs created require significant technical background. It is submitted that this is the true meaning of the so-called robotics revolution. The ability of the State of Michigan to meet the human resource demands of robotics technology will play a critical role in determing the success in making Michigan a world class center of excellence in robotics.

In summary, industrial robots are simply one more piece of automated industrial equipment, part of the long history of automation of production. Robots will displace workers in the same way that technological change has always displaced workers. There is a possibility that this job displacement will be a significant problem, particularly in a given occupation or industry or geographical area. There is also the certainty that robots will create new jobs. Education of the worker will be a major objective for American schools and universities along with national and local collective bargaining organizations.

COMPUTERS ACROSS THE CURRICULUM: EDUCATIONAL LEADERSHIP VS SCHOOL ADMINISTRATION

Nolan Estes*
Beatrice Curry~
Billie Kennedy~

ABSTRACT

Computers use as an instructional productivity tool has not been developed anywhere near its potential. Before micro technology will be excepted and used by teachers across the curriculum, the problems of resistance to change, professional development, software, economics, administration, technology, and research will have to be addressed by the school administration. By the year 1990, computer technology will have made dramatic advancements. The educational leadership will have to be prepared to meet these new challenges.

INTRODUCTION

The computers in our schools today function in three roles. They are a study unto themselves, they function as an assistant in the delivery of instruction, and as a device to improve the operational components of the instructional program. Their use as an instructional productivity tool across the curriculum has not been developed anywhere near its potential. The computers of today can, and the technology of tomorrow will, make teachers more effective.

Problems related to developing and implementing a program of wide spread computer use will have to be addressed before computers can be accepted and used by teachers across the curriculum. These problems can be categorized into seven areas: resistance to change, professional development, software, economics, administration, technology, and research.

ISSUES AND PROBLEMS

All teachers differ in their backgrounds and training. Some have had bad experiences with technolgy and are computer shy. Others try to fit the new technology into their usual way of conducting class, and they find that an incompatibility of technolgy and their

---

*Professor of Educational Administration, Univ. of Texas, USA.
~Doctorial Students, Educational Administration, Univ. of Texas, USA.

teaching style exists. Change is slow, and most of us are resistant to change. The first step in implementing the use of computers across the curriculum is to recognize and reward those teachers who are willing to bring technology into their classrooms and to the forefront in their districts.

To help teachers make a transition into the microelectronic revolution, we must provide professional development. School districts must stimulate the interest of teachers to participate in both preliminary and advanced computer workshops and courses by providing time for them to be involved in the activities. Only when teachers, and administrators, are truly computer literate and understand the capabilities of the technolgy, will they allow computing to be a part of their instructional process.

The problems with software are numerous including the availability for curriculum support, expense, and copyright protection. School districts must begin to offer incentives to teachers to help in the development of software for their courses and create a vehicle for their dissemination.

At a time when there is increasing competition for the educational dollar, economics becomes a vital issue in implementing computers across the curriculum. Unfortunately, many districts today are unable to afford upgrading of equipment, professional development, maintenance and repair, and research. Expenditures in the future, on new advanced technology, may prove difficult if we can not prove the expenditures of today are having a positive effect on the educational process.

For implementation of micro technology throughout the schools, there must bo support at the school administration and central office level. To lead us into the 21st century, administrators must be computer literate, have an understanding of programs necessary to ready students to access and use information in data bases and be dynamic leaders who are willing to implement these changes.

The biggest technological problem facing educators today is the constant upheaval of the market. There is a disrupting force from the hardware vendors in producing new, and discontinuing the old, models of computers. In addition, the incompatibility of hardware and software only makes the educator more frustrated. These problems will most likely continue through the 1980's as standards evolve and technolgy continues its advances.

The last area of concern is that of research. Before we can justify expenditures of funds in this time of accountability, we must have information on the educational and developmental consequences of children using technology. School districts must become involved in the design and development of research projects and the dissemination of information.

SIGNIFICANT DIRECTIONS IN INSTRUCTIONAL COMPUTING

Computers will not go the way of so many of the technological advances used in education in the 60's and 70's. They will not be put in the closet to gather dust, the technology will instead continue to advance and will become an indispensible tool for the increased productivity of teachers.

In the 1990's computers used in the schools will advance from single to multiple capabilities. Moving images will be freely mixed with text, numbers, graphics, or still frames in different "windows" on the same large screen. The workstation will easily speak to the user, and the user's voice will be used for input of commands or for verbal give-and-take with an instructional simulation. A telecommunications link will allow you to consult any database. If this is not enough, you will be able access other stations, micro, mini or mainframe computers to do the job.

They will move from PC's to workstations that no longer stand alone, but are powerful networks. As microcomputers become more powerful, it will make better economic sense for students to use small networks of three to ten students per one central processing unit. The networking of machines will allow for an "instructor level" in the operating system which will establish protected files of student perfomance on different programs, suggested sequences for instruction, and even a message system for communicating between instructor and students.

In the area of information storage and retriva, the compact disk will soon become a visible innovation. In most formats, today's compact disk can hold up to the equivalent of 250,000 pages of text, thus making it a suitable technology for storing small databases. Currently, the compact disks provide for playback only, but in the future it seems reasonable that on-site recording capabilities will be added.

Lastly, the computers of the schools of tomorrow will have "intelligent" computer assisted instruction. The computers will have abilities such as learning, adapting, reasoning, guessing, and emulating.

Clearly this technology will move education in new directions and school leadership will determine the development of the potential which technology offers to education. The new directions in technology offer challenges that in the true tradition of our profession we will be resilient and meet.

CD-ROM: A TECHNOLOGY FOR EDUCATION

Dennis F. Tanner

ABSTRACT: CD-ROM (Compact Disc, Read-Only Memory) represents a new publishing medium for education. As with any new technology, it presents both challenges and opportunities for educators and for educational publishers.

This document describes the medium, describes how it can be used in education, and offers examples of some CD-ROM products that are now available.

WHAT IS CD-ROM?

CD-ROM is a publishing medium for use with computer systems. The physical medium is like a compact disc for audio systems. A CD-ROM drive that connects to a computer can read the information on this CD-ROM.

Each CD-ROM can hold up to about 550 megabytes of read-only information (or more than 150,000 pages of text). That is equivalent to 760 floppy disks (720K each) or eight seventy-meg hard disks. This allows publishers to provide large databases such as Grolier's Electronic Encyclopedia or Books in Print on a disc that will fit in you pocket.

Some advantages of CD-ROM include the relatively low cost of the drive ($600-$1200 US) and media ($20 US manufacturing cost), the vast amounts of information it can contain, the fact that the data cannot be erased, and the small size of the CD-ROM which makes it easy to distribute.

Some disadvantages of CD-ROM are its slow speed (30% as fast as a hard disk) and the fact that the user cannot write information to it.

Several companies manufacture CD-ROM drives: Sony, Phillips, Hitachi, Toshiba, Western Digital, Digital Equipment Company, and others. These drives work with Tandy-compatible computers, as well as computers that can address a SCSI interface.

A close look at a CD-ROM shows us that data is stored as 3-dimensional pits on the disc, about two billion pits on a 3-mile track. The surface is sealed with a protective coating. The information is read with a laser inside the CD-ROM drive. Its estimated error rate is one bit/quadrillion bits (1 : 1,000,000,000,000,000).

HOW CAN CD-ROMS BE USED IN EDUCATION?

Because of its large capacity, the CD-ROM holds great potential for education. Schools and universities often have large reference works with large indices. An interactive program gives some advantages over traditional print material. In a print-based encyclopedia, for example, a student may have to pull out the index, look up articles related to the desired topic, pull out the volume of the encyclopedia, and find the right page. To include a quotation from the encyclopedia, the student must copy it manually.

With a CD-ROM-based encyclopedia, the student just types in the desired search word. The program may present the titles of a dozen articles that contain

---

Dennis Tanner is the Manager, Education Applications. He works for Tandy / Radio Shack Computer Applications in Fort Worth, Texas, USA. Phone: 1-817-390-3477.

references to that topic. The student chooses the article and presses a key. The program then displays the article on the screen for the student to read. Some encyclopedia also present graphics that correspond to the text. If the student wants to quote the article, he or she merely marks the text and sends it to a disk file for later use.

This use of the CD-ROM publishing medium is obvious and quite useful. Other uses are less obvious. For example, since the information stored is read by a computer, the information can be anything a computer can read from a diskette. That includes graphics, programs, and even digitized voice or sounds. Several programs listed below take advantage of these extra capabilities of computers.

One program stores lessons that will be run by students in a network. These lessons include programs, graphics, text, and digitized voice for instructions and reinforcement. Another application has maps of the United States and of the world. A third application stores images of more than 17,000 pages from science textbooks that can be printed by laser printers. The applications are limited only by the imagination and the resources of the developer.

WHAT APPLICATIONS ARE CURRENTLY AVAILABLE?

Below is a list of some CD-ROM applications that are now available. The author chose these applications because of their usefulness in a school or university. They are listed alphabetically by publisher. A list of sources for these products appears after the list of products.

Dialog Information Services offers DIALOG Ondisc ERIC which provides access to abstracts of articles published in over 700 educational journals and thousands of research reports, evaluations studies, curriculum guides, and lesson plans collected by the U.S. Department of Education. ERIC corresponds to two printed indices: Resources in Education and the Current Index to Journals in Education.

Education Systems Corporation has developed a networked elementary curriculum package that uses a CD-ROM for central storage of more than 1500 lessons. The system sends reading and math lessons to up to 40 students according to a preset schedule. The systems maintains complete records of each learning session.

Facts on File Inc. has a computer version of The Visual Dictionary. This product shows graphic images of common objects with English and French labels. The object names are both displayed and spoken.

General Research Corporation offers LaserQuest which contains records of 4.6 million library books, serials, visual materials, maps, and manuscripts on four CD-ROM discs. It includes the holdings of more than 1000 libraries. Users can search the information by title, author, identification numbers, and other descriptors. GRC produces bimonthly supplement discs with about 150,000 new titles with each edition.

Geovision, Inc. is producing a series of Geodisk CD-ROMs with geographically accurate maps on them. Their products will eventually include national, regional, state, and metropolitan map series. These maps are stored in vector format to facilitate manipulation while maintaining accuracy. Information included on these maps includes county and state boundaries, roads, railroads, place names, contours, waterways and more. The complete United States Geodisk is available now. The state CD-ROMs are being produced.

Grolier Electronic Publishing, Inc.'s Electronic Encyclopedia is the best known and probably most widely distributed CD-ROM application. It contains more than 100 megabytes of information in 30,000 articles. The Electronic Encyclopedia is used as a reference tool, probably mostly in school libraries.

Interage Research, Inc. produces Fast Past, a history database on CD-ROM. It allows the user to select a year in history, a part of the world, and a topic. Then it presents information for that year, area, and topic. Several thousand articles are available for review.

McGraw-Hill Book Company has introduced the CD-ROM Science and Technical Reference Set. This product includes the 7300 articles from the McGraw-Hill Concise Encyclopedia of Science and Technology, and the 98,500 terms and 115,500 definitions of the McGraw-Hill Dictionary of Scientific and Technical Terms. Articles in the encyclopedia and terms in the dictionary are integrated for quick access to all available pertinent information. Information can be printed, copied to a diskette, or sent to a word processing program. With Reference Technology's optional Docusystem (TM) graphics, the user can access photographs and illustrations on the screen. These images can be sent to a laser printer.

Microsoft Corporation has developed Bookshelf, its first CD-ROM application. Bookshelf combines the following reference materials on one CD-ROM: The American Heritage Dictionary, Roget's II: Electronic Thesaurus, The 1987 World Almanac and Book of Facts, Bartlett's Familiar Quotations, The Chicago Manual of Style, Houghton Mifflin Spelling Verifier and Corrector, Forms and Letters, U.S. ZIP Code Directory, Houghton Mifflin Usage Alert, and the Business Information Services Directory. These references are available from within a dozen popular word processing programs. This product is useful for journalists and other writers.

PC Software Interest Group (PC-SIG) offers a CD-ROM containing more than 600 public domain and user-supported programs for MS-DOS computers. The software includes utilities, games, spreadsheet templates, specialized vertical market programs and databases, and software such as PC-Write, PC-File, and PC-Talk.

PC-SIG also offers a science program. Dr. Mary Budd Rowe of the University of Florida, Gainesville, has spearheaded the Knowledge Utilization Project in Science with a Carnegie grant. This project involves digitizing more than 17,000 pages of K-8 science books from the 1960s. The pages can be viewed on a computer screen and printed on a laser or dot matrix printer. PC-SIG is marketing this product.

Quantum Access, Inc. produces The State Education Encyclopedia, a state-specific database which contains "all the administrative documents needed to run a school in Texas." These include educational statutes and regulations, Title 19 of the Texas Code, curriculum specifications, special education requirements, accounting procedures, the tax code, the election code, the family code, twelve years worth of memoranda from the commissioner of education, and appeals of various decisions.

Silver Platter Information Services offers several databases on CD-ROM:

ERIC (the Educational Resources Information Center) database is the national U.S. bibliographic database covering the literature of education. One of the most widely searched databases in the world, it includes Resources in Education and Current Index to Journals in Education.

PsychLIT incorporates Psychological Abstracts, a library's major resource for information in psychology. It includes information from the new database from the PsycINFO Department of the American Psychological Association. It covers more than 1300 journals and monographic series from 45 countries.

Sociofile is a subset of Sociological Abstracts, and offers detailed abstracts from more than 1200 serials covering the world's literature in sociology and related disciplines since 1963.

AV ONLINE, the database of the National Information Center for Educational

Media, contains information on 300,000 audiovisual materials, covering videotapes, films, audio tapes, filmstrips, and other media on any subject.

LISA contains abstracts of the world's literature in librarianship, information science, and related disciplines as compiled by Library Association Publishing, Ltd.

Tescor, Inc.'s CD-ROM product is the First National Item Bank and Test Development System. This system includes more than 80,000 validated test items linked to 10,000 learning objectives in 38 K-12 subject areas. The product permits teachers to match their own learning objectives against those in the Bank. Then the teacher can select from a group of test items correlated to those objectives and edit the items if desired. The test (including graphics) can be printed on a laser printer or item numbers can be saved on a floppy diskette to order printed tests from Tescor. Printed tests can be used with generic answer sheets as input to Tescor's test-scoring system, which uses a scanner.

University Microfilms International, a Bell & Howell company, offers Dissertation Abstracts Ondisc, a CD-ROM version of their huge-book format "Dissertation Abstracts" database used for university research. The CD-ROM is updated annually.

Applications Publishers (All addresses are in the U.S.A.)

Dialog Information Services, Inc.
3460 Hillview Avenue
Palo Alto, CA 94304
415-858-2700

Education Systems Corporation
6170 Cornerstone Court East
Suite 300
San Diego, CA 92121-3710
619-587-0087

Facts On File, Inc.
460 Park Avenue South
New York, NY 10016
212-683-2244

General Research Corporation
Library Systems
P.O. Box 6770
Santa Barbara, CA 93160-6770
800-235-6788

Geovision, Inc.
20 Technology Park, Suite 160
Norcross, GA 30092
404-448-8224

Grolier Electronic Publishing, Inc.
95 Madison Avenue
New York, NY 10016
212-696-9750

Interage Research, Inc.
7619 N. Rogers
Chicago, IL 60626
312-764-1892

McGraw-Hill Book Company
Consumer Group
11 West 19th Street
New York, NY 10011
212-337-5026

Microsoft Corporation
16011 NE 36th Way
Box 97017
Redmond, WA 98073-9717
206-882-8080

PC-SIG
1030D East Duane Avenue
Sunnyvale, CA 94086
408-730-9291

Quantum Access, Inc.
1700 W. Loop South, Suite 1460
Houston, TX 77027
713-622-3211

Silver Platter Information Services
37 Walnut Street
Wellesley, MA 02181
617-239-0306

Tescor, Inc.
461 Carlisle Drive
Herndon, VA 22070
800-842-0077
703-435-9501 In Virginia

University Microfilms Int'l.
Electronic Publishing
300 North Zeeb Road
Ann Arbor, MI 48106
800-521-0600

GRADUATE DISTANCE LEARNING THROUGH INTERACTIVE MICROWAVE EDUCATIONAL CENTERS

LINDA A. ZURFLUH*

ABSTRACT

The utilization of microwave and satellite telecommunications was explored to provide graduate level distance learning to potential and practicing school administrators from a university main campus to multiple and distant branch campuses. Distance learning literature was reviewed. The delivery system explored involved interactive microwave transmissions, supplemented with electronic bulletin boards and electonic database informational accesses. The primary intended outcome of this exploration was to meet the need to provide quality instructional programs necessary to train individuals in the role of the school principal over a minimum of three separate sites spanning approximately two hundred miles. Six additional intended outcomes were cited.

INTRODUCTION

Graduate training programs for the principalship have historically been faced with student populations which are impacted by cyclical growth and decline. These cycles are reflective of the fact that the principalship is a highly specialized role with jobs generated by the fluctuating supply and demand of the market place. Responding to expressed student needs across multiple locations requires the availability of university programs at multiple geographic sites. However, off-campus university programs have inherent difficulties with the maintenance of program instructional quality and university ancillary services. Is it possible that the apparently dichotomous need to provide instructional services across multiple locations and the off-campus difficulties inherent in doing so might provide the basis for creating and implementing an educational delivery model which meets the multiple location needs and eliminates the historic difficulties of off-campus instruction? Further, is it possible that this model might be an instructional key to providing for the self-directed continuing education of principals at work or at home?

---

*Associate Professor of Educational Administration, Western Washington University and Program Coordinator: Western Washington University Seattle Campus, 1801 Broadway Room NP 101, Seattle, Washington 98122

DISTANCE LEARNING

"Distance learning", "distance education" and "distance delivery" are essentially synonymous terms which describe programs largely resulting from the 1970's and 1980's which sought to provide study without having students in one location or under the continuous, immediate supervision of instructors (ref 1). Goldstein (ref 2), defines distance learning as "recognized learning that takes place at a site remote from the point of origination," with "recognized learning" defined as instruction delivered to the learner through either a passive or interactive electronic medium or a combination of media (e.g., open broadcast radio and television, Instructional Television Fixed Service ((ITFS)); "bicycled" distribution of tapes or discs; cable, microwave and satellite systems; telephone networks; or computer-assisted instruction). Optimum distance education has been defined by Keegan (ref 3) to include the following components:

1) the separation of teacher and learner, which distinguishes it from face-to-face teaching;

2) the influence of an educational organization which distinguishes it from private study;

3) the use of technical media, usually print, to unite teacher and learner and carry the educational content;

4) the provision of two-way communications so that the student can benefit from, or even initiate, dialogue;

5) the possibility of occasional meetings for both didactic and socialization purposes.

TRANSMISSION MEDIA

The five main forms of information transmission (ref 4) include:

1) wire carriers, commonly in open wire or twisted wire pairs, that can carry a limited amount of transmission traffic from one point to another;

2) coaxial cables that enable high frequency signals to be sent through insulated wires and can accommodate a larger number of voice channels than can the wire carriers;

3) microwave propagation through the air that allows voice, video and data signals to be transmitted on a continuous wave oscillation of a single tunable frequency;

4) optical fibers composed of thread-like glass wires that are capable of carrying nearly 1,500 voice conversations or two television channels of information for distances up to four miles before reamplification is necessary; and

5) satellites that have combined space and telecommunications technologies (microwave transmission) to provide geosynchronous

communications relay terminals in order to establish telecommunication services across vast expanses of land and water.

Any of the above media are capable of transmitting audio, visual and data electronic signals and may be utilized singly or in any media combination to create a telecommunications network (ref 5).

A PROPOSED MODEL FOR GRADUATE INSTRUCTION

While satellite technology offers distance-coverage advantages, its costs are often prohibitive. Local loop technology (the mode of transmission used to carry a signal to a satellite uplink), utilizing transmission media other than satellite (especially microwave, fiber optics and coaxial cable), can provide for less costly distance learning while maintining the ability to interface with a satellite network at a later date.

Line of sight microwave transmission can travel approximately twenty-two (22) miles without redistribution or boosting requirements. Utilization of a series of transmittal sites could extend microwave communications capabilities from the main campus to multiple branch campuses along a two hundred (200) mile "service corridor" to the south. Microwave transmission would provide: (1) interactive audio and video linkages with all three current instructional sites, as well as provide for immediate additional instructional sites within the tranmittal radius, (2) simultaneous instruction to all instructional sites, with instructional transmittal from faculty on main campus and/or branch locations, and (3) improve the utilization and availability of faculty for instructional, advisory and informational purposes. Cost effectiveness is at issue with microwave transmission, largely because of the initial expense of transmittal stations. However, businesses within the private sector are currently completing plans to establish a series of transmittal sites within the service corridor and are receptive to sub-contracting off-hour time to accomodate evening course instruction.

An alternative to microwave transmission is cable television with accompanying telephone utilization. While not as desirable as microwave transmissions, due to the separation of audio (via telephone) and video (via cable television) transmissions, this does provide a usable interactive system.

COMPUTER ACCESS TO COMMERCIAL DATA BASES

At each instructional site, computer modem/telephone linkages with electronically transmitted commercial databases would provide students with access to graduate reference and research information. Instructional support materials richer in content than most graduate libaries could be electonically accessed and utilized in conjunction with distance instruction. This new form of graduate learning would provide students with a model for self-directed continuing education through computer linkages at their professional work sites or homes.

UNIVERSITY ANCILLARY SERVICE ACCESS

On site electronic bulletin board and other computer modem/telephone linkages with the main campus will assure faculty, staff and students the necessary access to ancillary services such as: registration, graduate school, placement center, records database, bookstore, departmental administration and others. This is a critical linkage for all concerned, and would be a central focus of each instructional site.

INTENDED OUTCOMES OF GRADUATE DISTANCE LEARNING

Multiple instructional sites serviced by interactive microwave, electronic bulletin board and computer linkages to commercial electronic databases would provide the following educational improvements:

1) expansion of program offerings at each branch site,

2) increased interdisciplinary collaboration due to expanded capabilities and improved flexibility,

3) the creation of a new partnership between private business and the university in the development and utilization of this communications system,

4) instructional modeling to equip self-directed continuing education of learners through computer capabilities at the work site or at home,

5) improved cost effectiveness for instructional delivery, and

6) student access to university coursework in remote and/or rural areas previously not served by the state university system.

REFERENCES

1. M K Johnson, C Amundsen, Paper: Annual International Convention of the Council for Exceptional Children (61st, Detroit, Michigan) 1983.
2. M B Goldstein, Issues of Law and Policy Affecting Telecommunications Based Distance Learning (S.W. Ed. Development Laboratory, Austin) 1984.
3. D Keegan, Distance Education 1(1), 13-36 (1980)
4. J-P Emard, Report for the Subcommittee on Science, Research and Technology (U.S. House of Representatives, Washington, D.C.) 1981.
5. S Grieve, N Singer, Report to the Office of Vocational and Adult Education (Washington, D.C.) 1984.

COMPUTING FOR THE TERRIFIED AND THE MERELY IGNORANT

Jonathan Darby*

ABSTRACT

In an institution like Oxford University, ignorance about computers and what they can do is still the norm and not the exception. This ignorance is often reinforced by fear. I examine the approach taken by the Computing Teaching Centre in making computers accessible to all.

INTRODUCTION

Oxford University's Computing Teaching Centre (CTC) is still unique in the UK university community in being an independent department charged with the task of providing a computing teaching service for the whole university. In other universities this role is performed either by the computing service or by the computer science department, but for us, teaching computing to non-computer scientists is our primary specialism. About half of our teaching is done "under contract" to other departments but the remainder of our courses are offered to any member of the university.

We had been aware for some time that while our services were well used by science students, other groups of students were giving us a wide berth. In 1984/5 a male student was three times more likely to visit us than a female student, and a science student was eight times more likely to come on a CTC course than an arts student. For the last three years we have been trying to remedy this situation in a number of ways.

COMPUTING FOR THE TERRIFIED

In 1985 Kitteridge Cowlishaw was seconded jointly to CTC and Somerville College by IBM for two years. She identified some of the factors keeping people away from computing classes as:

- fear of failure
- unwillingness to commit a large amount of time
- anxiety about the rest of the class being much more able
- belief that they would never understand what it was all about anyway

---

*Teaching Officer, Computing Teaching Centre, University of Oxford,
59 George Street, Oxford OX1 2BH.
JANET Address: JONATHAN@UK.AC.OXFORD.VAX

Her solution was to design a course that would:

- guarantee success
- take only one afternoon
- by its title attract like minded students
- allow students to ask "embarrassingly basic" questions anonymously
- provide a high level of personal attention

Thus it was that "Computing for the Terrified" was born and it has been a "sell-out" now for more than two years. In three hours students get to use "real" computer software - word processing, database, spreadsheet and even programming. The practical exercises guide students step by step so that success results from following the instructions. They are also humorous, which helps undermine anxiety! Numbers are kept to a maximum of twelve with a tutor and a demonstrator. Creating the right atmosphere is a vital part of the course, and the tutor must establish a close rapport with the students within the first 10 minutes.

"Computing for the Terrified" has succeeded in two ways. It has succeeded in attracting the sections of the university community that have been seriously under-represented in the past - arts students, women and older academics. Second, overwhelmingly, students have left the course with their fear of computers banished. Many who would not otherwise have done so have gone on to take other courses at CTC.

COMPUTING FOUNDATION

Until three years ago we introduced students to computer usage through programming. With the growth of application software, particularly for microcomputers, this approach became inappropriate. We were also finding that students were trying to solve problems through programming where other approaches (e.g. database or spreadsheet) would have been more appropriate. We decided to design a foundation course which would be the normal starting point for inexperienced students. Our main objectives for the course were to:

- introduce students to a representative range of software
- use state-of-the-art software
- prepare students for further courses in computing
- demystify computers and their uses
- include at least 50% practical work

Our first iteration of the course made use of 8-bit microcomputers and the possibilities were limited by this constraint. We recently re-equipped with high performance AT-compatible computers* and we have completely revised the course to take advantage of this.

---

* Research Machines Nimbus AX computers each with EGA colour graphics, 3Mbytes RAM, mouse and Z-Net network interface.

SOFTWARE CONSIDERATIONS

Our aim was to employ software that was easy to use, powerful, visually attractive and widely utilised. Since we should of necessity be using a wide range of applications we also wanted to minimise the number of different driving mechanisms that the students had to learn. We started by looking at various integrated software packages but none of them could meet all our other aims. In the end we decided on Microsoft Windows as the framework around which to construct the course. We chose Windows because of the intuitive nature of its use of mouse and pull-down menus. We did not however want our students to have to select programs by name directly from Window's MS-DOS interface, so we used a product called ClickStart to generate a menu front end to Windows.

The Foundation Course lasts for four three-hour sessions broken down as follows:

Session A	Introduction to computer concepts using the BBC Domesday System as a vehicle
	Storing and retrieving information using Windows Cardfile
	Demonstration of the Cambridge University Library System
	Introduction to databases using DataEase
	Demonstration of Prestel
	Discussion of social implications of database use
Session B	Using computers to process numbers and produce graphs using SuperCalc4
	Electronic mail (local and to/from USA)
Session C	Word processing using Windows Write and Windows Spell
	Creating illustrations with Windows Paint
	Integrating text, graphics and spreadsheet data using Windows
	Demonstration of desktop publishing using Ventura
Session D	Introduction to programming using RM Logo
	Preview of CTC second and third level courses

HARDWARE CONSIDERATIONS

We have more than 60 computers for student and staff use and we consider a network to be essential. Unfortunately the one thing networks are not good at is servicing a large number of users simultaneously. We have solved this problem by using 2Mbytes of RAM in each workstation as virtual disk. We then preload this "disk" with the software required for that session and the students work directly from it, using the network only for print spooling and permanent file storage. In this way we achieve response times superior to those that would be achievable with a hard disk in each workstation.

A MULTI-DISCIPLINARY COMPREHENSIVE COMPUTER APPLICATIONS COURSE

A.C.KRIZAN.

ABSTRACT

All college and university graduates need to be familiar with the operation of microcomputers when they enter the work force. They should be familiar with the more common DOS commands and with word processing, spreadsheet, data base management, and graphics software programs. It is the responsibility of educators to determine the most effective method of implementing this instruction into the curriculum. One method is to design a comprehensive course which includes instruction on all the software programs and includes material which is applicable to every discipline on campus.

INTRODUCTION

Technological advances have made it difficult to find an organization without microcomputers. In order for graduates to be competitive in finding jobs and in getting promotions, they probably will have to operate microcomputers. Graduates lacking a familiarity with microcomputers will be unproductive which may lead them to become frustrated. Students cannot be taught all of the software programs that are available; however, they can learn the concepts of each type of program. This paper will discuss a microcomputer applications course which can be used to introduce concepts of each type of application and explain how it may be integrated into a school's curriculum.

NEEDS OF STUDENTS

The most effective way for an institution of higher learning to present the concepts of microcomputer software programs to their students is through the use of a single course for all its disciplines. The major consideration in establishing this course should be the computer needs of the students. After careful analysis you will probably find that students in the various disciplines have similar needs--familiarity with computer terminology, ability to operate the computer, familiarity with computer hardware and software, and alleviation of the fear of computers.

CONTENT OF THE COMPREHENSIVE MICROCOMPUTER APPLICATIONS COURSE

A course should be designed that will fulfill as many of the students' needs as possible. The content of the course should include equipment orientation, disk operating system, word processing, file management, spreadsheets, graphics, and integration of packages. There is much material to cover in a relatively short period of time. One breakdown of content to time that has worked successfully in a semester course is: equipment orientation--1 hour; disk operating system--2 hours; word

Department of Office Systems and Business Education, College of Business and Public Affairs, Murray State University, Murray, Kentucky USA

processing--12 hours; file management--10 hours; spreadsheets--12 hours; graphics--2 hours; and integration of packages--6 hours.

GAINING FACULTY SUPPORT FOR COURSE

This type of course will only succeed when the support of faculty is gained. Faculty must be made aware of the importance of computer literacy. When faculty members know more about the course's content, the chances are better that they will advise students in their discipline to enroll in the course.

One excellent way to inform faculty members about the course's content is to offer a faculty workshop for an entire semester. Use the same software during the workshop that will be used in the course. The faculty members will become familiar with software that they can use for their administrative work as well as integrate into their classes. Using the same software also makes the faculty aware of what the students will be exposed to.

Additional support for the course can be gained by assisting individual faculty with integrating microcomputer material into his or her courses.

NEEDED FACILITIES TO SUPPORT APPLICATIONS COURSE

A classroom and a laboratory facility will be needed for this course. It is possible to have the same room serve both functions if it is not being used for other classes. Students will need ample time to work on application exercises to reinforce the concepts learned in class.

A room to house the hardware will need sufficient electrical outlets. Many times an old typing room can be modified with minimum costs. When selecting the hardware, consider the memory capacity that the microcomputer will need to support the software. Consideration should be given as to what software may be used in the future.

Equipment portability may be another consideration in selecting the hardware. If the class is to be offered at a remote site, portable equipment will make it easier to transport. However, using portable equipment also increases the security risks.

Printers may become an issue when planning the microcomputer facility. Will the students use printers in the classroom or will they print to diskettes? If it is determined that printers are needed, how many and what type printers will be the best? At Murray State University the teaching classroom contains 40 microcomputers with no printers. Students print their assignments and exam solutions to diskettes. The study laboratory is equipped with 30 microcomputers and eight printers. This 4 to 1 ratio works well.

Another consideration will be should the printers be daisy wheel, dot matrix, or laser. A daisy wheel will provide better quality print than a dot matrix but will be slower and will create more maintenance problems. A laser printer will provide high quality print at a high speed, but the cost, initial purchase and operating, will be considerably greater.

The speed of printing may be another concern when purchasing printers. A laser printer will be faster than the other type printers. The slowest printer will be the daisy wheel. All these printer characteristics should be considered prior to purchasing the equipment.

You will also have to decide if the computer monitor should be monochrome or color. There is a significant difference in prices of the two. Other considerations when purchasing microcomputer equipment are will you need a graphic capability? Modems? Should the equipment be networked?

SELECTION OF SOFTWARE FOR COURSE

The primary consideration when selecting software to use in the course should be the objective of the course. Some institutions select software that is most widely used in business organizations. This software is many times the most expensive on the market. If the objective of the course is to introduce students to application concepts, many times an inexpensive software can be effective.

An alternative to expensive, popular software is a publishing company's reduced versions. Most of these versions can be used effectively in an educational environment where concepts are being taught. Another option is purchasing cheaper, out-of-date software. This option is probably the least satisfactory of the alternatives. A third alternative is to use shareware programs such as PC File, PC Write, Express Calc, and Express Graph. This is the option that has been selected at Murray State University, and it has worked well for the introductory course.

OBTAINING COURSE MATERIALS

The easiest way to get course materials is to adopt a textbook from a reputable publishing company. There may be difficulty in finding a text which accomplishes the objectives of the course and satisfies the needs of the students. An alternative is to use the manual which comes with the software. Most manuals are written to be used as a technical reference and not as a course textbook.

If you are not satisfied with the other alternatives, you can develop your own materials. Assistance can be obtained from teachers in the other disciplines. They should be able to provide realistic problems from their area of expertise. Ideas may also be obtained from the top students in your classes. If material is added to the course each time the course is taught, you will have many worthwhile exercises after several semesters. Articles in computer magazines can also be a valuable source of course materials.

One drawback in developing your own materials is the enormous amount of time that is needed. Few institutions will give their instructors release time to prepare teaching materials.

CHALLENGES FACING INSTITUTIONS

Developing a multi-disciplinary comprehensive microcomputer course can be rewarding while providing many challenges. A major challenge is convincing the administration to provide funds for purchasing enough equipment for keeping equipment up to date.

Teaching this course can be very time consuming. As explained in the previous section, much time can be spent in developing teaching materials. Time is also needed to evaluate new software packages.

Assisting students outside of class with application exercises will take an instructor's time if well-trained student assistants are not available. Student assistants who are competent in computer applications can be difficult to hire. It is easy for them to get more money by giving private tutoring lessons.

The challenge of finding competent instructors is a major one for institutions. With the demand for computer courses, there is a severe shortage of instructors specializing in computer applications.

Offering a multi-disciplinary comprehensive microcomputer applications course can be rewarding. Students will leave the institution better prepared for the work force. Your department will have a better image in the eyes of the administration, the students, and other faculty. There will be improved relationships between students as they help each other with application exercises. The rewards far outweigh the disadvantages.

TURBO PROLOG GRAPHICS AS A TOOL FOR MIDDLE SCHOOL CHILDREN TO LEARN THE CONSTRUCTS OF PROLOG

Gary W. Tubb, Ph.D.*

ABSTRACT

A pedagogy for instructing adolescents in the programming of Prolog is presented in this paper. The focus of the instructional method is graphics. The system of learning is based upon the process often used in LOGO to acquire LISP concepts. Fundamental programming concepts of block structure (procedure, local variable) and control structures (recursion) of LISP are introduced in LOGO within a limited data structure - graphics. The proposed Prolog instructional model is couched within the Artificial Intelligence area of two-dimensional pattern recognition and capitalizes upon the graphics capabilities of Turbo Prolog.

INTRODUCTION

The introduction of programming languages to adolecents in public schools has become financially feasible and fashionable with the advent of microcomputers. Often these young minds experience the structure of a computer programming language's syntax in the context of a limited data structure. For example, fundamental programming concepts of block structure (procedure, local variable) and complex control structures (tail-recursion, embedded recursion) of LISP are introduced in LOGO with a limited data structure - graphics. Similarly, Pattis (1982) introduces the syntax of PASCAL in his microworld KAREL the Robot . Microworlds are simulated models of the real world that follow selected, unambigious rules. Thus, the programming of logical concepts that are dealt with in microworlds are much easier to understand (Hanna, 1986; Sowa, 1984). Microcomputers afford educators an opportunity to teach foundational programming languages designed around graphics-based microworlds.

The pedagogy outlined in this paper suggests a graphics-based microworld for teaching fundamental concepts of Prolog. The author believes that a successful programming language pedagogy has two components: the notion of a "powerful idea" (Papert, 1980), and an extensible microworld constructed around the powerful idea. The "powerful idea" is the Artificial Intelligence (AI) area of pattern recognition. The microworld is a robot's probing of geometric figures and their relationships.

---

* Instructional Computing HMS 442, University of South Florida, Tampa Fl 33620, USA, BITNET# DNPABAA at CFRVM

POWERFUL IDEA

Powerful ideas are linked in such a manner that students add new parts to their inventory of mental models of the real world as well as the heuristics for proposing and solving problems based upon each powerful idea. Lawler (1984) believes that a powerful idea should be simple, general, useful, and syntonic. A simple idea is easily understood, but, to be general, the idea can be extended to other areas of thought and life. A useful idea is important in today's society. Of most importance, the student should be able to syntonicly (concretely) relate this powerful idea to previous knowledge and experience.

The AI area of two-dimensional pattern recognition is fertile with powerful ideas. Investigating the reasoning associated with classification of objects (regardless of orientation or size) may be organized in a building-block fashion that creates an anticipation by the student of upcoming problems and their solutions. For example, the notion of squareness introduced in LOGO results in a procedure:

```
TO Square
    REPEAT 4 ( FD 80 RT 90 )
END
```

Students believe they understand squareness - four angles of 90 degrees. Yet, when asked to create a triangle the typical student incorrectly creates the following procedure:

```
TO Triangle
    REPEAT 3 ( FD 80 RT 60 )
END
```

The immediate visual feedback provided by turtle graphics results in the student recognizing that the exterior angle (rather than the interior angle) is described in the procedures above.

This unsettling experience prompts students to reexamine their preconceived notions of regular polygons from the perspective of exterior angles. Analogously, Prolog programs may be constructed that prompt a student to reexamine their process of classification of simple geometric objects using angle recognition, key-points, or delta-D (Schildt, 1987).

MICROWORLD

Creating a microworld that allows students to reexamine the real world in a stimulating, non-ambiguous manner provides a starting point for the development of deeper knowledge and understanding of our world. Ennals (1986b) suggests that the graphic notation of LOGO be combined with the logical notation of Prolog in micro-PROLOG. However, the object of the study he describes was the teaching of logic rather than the teaching of Prolog. Briggs (1982) and Weir (1982) identify difficulties of the students that participated in the study and suggest that graphic representation of semantic networks should be emphasized, lessons should be project oriented (student centered) rather than teacher centered, more examples offered at a slower pace, and a query-the-user facility (allows user to be treated as an extension of the Prolog database) should be integrated into micro-PROLOG.

The microworld suggested in this paper is the two-dimensional world of a probing robot. Represented in graphics (like the LOGO turtle), the robot may move on the computer screen in two dimensions. Similar to Karel (Pattis, 1982), the robot can sense the existence of walls and the robot has a bag of "electronic potato chips" (ie. Karel's "beepers") that he may place as he moves about in his two-dimensional world. This probing robot has more advanced senses than Karel. He can detect color of objects and he has a radar that estimates distance to an object.

Initially, the probing robot explores a cavern that the students create. In an adventure format, the goal of the robot is to find the treasure room. The simple maze consists of rooms with one entrance and at most two exits (tree structure designed by students) that the robot probes in a depth-first search strategy. The database of rooms is graphically displayed on the computer screen. The robot can "backtrack" from the exit through the entrance of a room to a prior room by moving backwards. This, of course, is graphically demonstrated.

Then the robot investigates a square hallway and determines when he has returned to the starting location. This may be thought of as four rooms that interconnect to form a loop. The sequentially presented maze problems become progressively more complex with the introduction of rules that the robot follows in his searching strategies. Initially "electronic potato chips" substitute for the concept of "List". Finally, the concept of list is introduced in the same fashion that Clocksin and Mellish (1981) use to solve mazes.

A second level of difficulty arises when the probing robot escapes from his world of mazes and encounters unrecognized objects in two-dimensional space (triangles and squares). Pattern-recognition concepts are introduced at this time with extensive use of recursion and Prolog program control.

DISCUSSION

There are many pro's and con's to introducing fundamental concepts of Prolog with graphics rather than formal logic. Cox and Pietrzykowski's (1985) PROGRAPH or LOGRAPH may preserve the underlying constructs of Prolog in a fashion more representative of the original notions of Colmerauer.

Selected References

Briggs, J. (1982) Teaching Mathematics with Prolog , Bachelor of Science Thesis, Dept. of Computing, Imperial College, London.

van Caneghem, M. and D. Warren (1986) Logic Programming and its Applications , Norwood, New Jersey, Ablex Publishing Corp.

Clocksin, W. and C. Mellish (1981) Programming in Prolog , Berlin, Springer-Verlag.

Cox, P. and T. Pietrzykowski, (1985) Solving Graph Problems using LOGRAPH , in Jernigan et al (1985).

Ennals, R. (1986a) Information Technology and Education: The Changing School , New York, Halsted Press.

Ennals, R. (1986b) Teaching Logic as a Computer Language in Schools , in van Caneghem and Warren, 1986.

Hanna, J. (1986) Logic for Learning , in Ennals, 1986a.

Jernigan, R., B. Hamill, and D. Weintraub (1985) The Role of Language in Problem Soving , New York, Elsevier Science Publishers.

Lawler, B. (1984) Designing computer-based microworlds , in Yazdani, 1984.

Pattis, R. (1982) Karel The Robot: a Gentle Introduction to PASCAL and the Art of Programming , Morristown, New Jersey, Cybertronics International, Inc. Software Publishing Division.

Papert, S. (1980) Mindstorms - Children, Computers, and Powerful Ideas , New York, Basic Books.

Schildt, H. (1987) Advanced Turbo Prolog: Version 1.1 , Berkeley, California, Osborne McGraw-Hill.

Sowa, J. (1984) Conceptual Structures - Information Processing in Mind and Machine , Reading, Mass, Adison-Wesley.

Weir, D. (1982) Teaching Logic Programming: An Interactive Approach , Master of Science Thesis, Dept. of Computing, Imperial College, London.

Yazdani, M. (1984) New Horizons in Educational Computing , New York, Halsted Press.

AI, GADFLY OF EDUCATION

Carolyn Bollenbach

ABSTRACT

Language-logic, the tool of Artificial Intelligence, and intuition are historically viewed as opposites. Some AI researchers are exploring causality as a factor of intuition; others are creating machine designs that simulate brain processes which abstract patterns, intuition's forte. On the other hand the educational system is not researching intuition as a component of intellect. AI can lead the way in optimizing the integrated use of intuition and language-logic processes. Input from industrial and educational research and development are needed to ask and answer questions about the impact of computers on developing minds.

AI SUCCESS AND TRENDS

Advocates of artificial intelligence may strongly believe as some brain researchers do that mind is a fallacious concept. The presumption is that a mechanistic brain can be simulated and that language can be analyzed and programmed. Consequences of this orientation have revolutionized the planet and space. Yet AI explores beyond digital computers to brain simulations that assume an extra-logical process such as collective decision circuits to connect associative memory or optical technology with neural models to solve random problems of pattern recognition or machines based on principles of parallel distributed processing challenging functionalist attitudes. Linguistic analysis continues turning toward intuition's input in the content of common sense and the process of determining causality. The variety of math scales are extending to qualitative measurement for fields as psychology and sociology. Do such events imply cognition is more than language manipulation? Can AI accommodate intuition?

CONTEXT BUGS

An extreme leap for logic is a speculation of Carl Pribram, neuropsychologist; individuals can access a universal hologram memory. Will computerized holographic patterns be the ultimate mechanization? Or will the AI community confront a barrier similarly to the physicist community? Heisenberg's uncertainty principle evolved quantum mechanics, primed remarkable events and left physicists philosophically stunned at being able to measure with only a probability of correctness. Does humanity have the capacity to live with uncertainty? At the moment lay citizens feel displaced even outraged that technology is at the helm of individual universes. Wanting assurance many have renewed church vows. Some scientists are exploring mystical concepts. Are the ramifications implied about a computerized, mechanized spacestation hyperbole? Take a random look. An American teen interviewed on TV after his friend had just died in a dirt bike accident commented, "I'll keep riding; we might as well have fun before we die." Is there agreement from school dropouts to the best teen computerites? Not long ago bored with mechanical expertise the latter chose to creatively access private networks.

For a score of years since the sixties mechanistic, behavioral psychology dominated text content and method. The contrast between six year olds allowed only to recite as manipulated by teacher or text and those encouraged to spontaneously express intuitive awareness is dramatic. The use of concrete, sensory analogy to draw intuition and imagination into problem solving situations dramatically explored outflanks even computers. Yet drill has reached preschools. Currently five year olds see psychologists because they are burned-out from early abstractions. Educational reform spars about trivia. Parental orientation may unwittingly contribute to blocking intuition.

ABSOLUTES OR RISK?

One Fall six year old memorizing robots arrived in class holding their stance until Christmas. Then with the childish emotion and awe that Noel evoked inhibitions dissolved. Priming whole-hearted receptivity Christmas symbols of other lands breathed life into geography and history. Students bonded with the external historical world. Their emotional holiday joy freed curiosity to experience in the sensorimotor mode of intuition and facilitated absorption of great ideas beyond skills for the term. Acting as blinders early abstract emphasis deprives body-mind of a priori bases for perceiving essense. By arousing emotion even high school students do transcend to new dimensions. Having to press-agent the Odessey, I brought material on archaeology; a total dud for students demanding relevancy in the late 1960s. The next day colorful fairytales invited emotional commitment. There was immediate capitulation except one six foot male locked the door to avoid school scandal. They were asked to keep in mind four abstract questions related to economic, government, religious and social institutions. After fairytales myths were consumed. Two days of such inspired reading opened minds to the Odessey which was read not only without complaint but with fascination. A test with global questions indicated they had discovered invariants across centuries. In awe they joined the human race. The young in heart that survive first grade are all ages. One serious physicist recommends complementing the study of physics with surfing since waves are the imagery needed to grasp the conceptual field.

Michel Foucault, The Archaeology of Knowledge (Pantheon Books, NY, 1972) p 25 illuminates the multidimensionality of conceptual fields which may expand awareness and vitalize discourse provided texts of past syntheses are reviewed in the present context and facts are removed from generalizations and sensed anew. French philosopher Foucault p 28 observes risk in language; "...a statement is always an event that neither the language (langue) nor meaning can quite exhaust." Is a comment fractal in nature? Intuition quickly measures and assimilates new aspects of generalities. Details accumulate with linguistic speed.

How does education use intuition to complement language-logic? R Rucker, Mind Tools (Houghton Mifflin, Boston, 1987) p 29 attests that information is noise unless there is an a priori map, a sensory experience base. Education ignores the insight phrased by John Dewey as begin where the child is. Listening to students to determine when and how to deploy information requires knowing how thinking proceeds. It also requires the humility to realize thinking is not taught, only enhanced. Or it is limited if overlain with a closed system of logic. Rucker p 286 "It turns out that there is a real sense in which our logic cannot reach out to anything more complicated than what it starts with."

Combine a quick look at some elements of intuition along with a consideration of how to survive without surety. Rucker p 286 believes that the concept behind the proof of Chaitin's theorem which extends beyond language to felt percepts implies conceptual existence even though the feeling cannot be verbalized. Can one program for what has not yet been comprehended verbally? In the 1800s Faraday felt how magnetism flowed in relation to electricity. He drew his imagery so precisely that Maxwell was able decades later to express the concept mathematically. Some of Albert Einstein's ideas were first sensed in his muscles; his imagery was often in 3-D and math symbols. Sensations feeding the intuitive hemisphere go far beyond the five senses, e.g., magnetic, chemical, muscular energy, balance, rhythm. Anyone or a combination may code an address and originate a new perspective. Do a priori neuron groups begin with dueling a fierce March wind with an umbrella; walking sideways up a steep incline; creating shapes with clay; measuring with literal feet? G Edelman, Neural Darwinism, reviewed Sci Am 258, 17 (1988) presents a theory that brain represents in neural groups only experienced events. In a complex era I assert that six or seven year olds steeped in concrete, sensory imagery, given a situational problem to solve or risk to take have met the conditions of actual experience. PreWWII children interacted with nature in a mainly rural society. Today developing awareness maps of nature's laws is not a stage of child development for earphone isolated youngsters.

Does risk-taking have an innate address in life forms? If from the first life speck there had not been a tendency to go beyond the present state, life would not have evolved. Intuition is the means to project beyond language-logic even while enjoying routines brought to daily living by language. Intuition seems to risk but greater perspective offsets those factors. A cursory view indicates intuition acts with multidimensions including processing feedback, emotion, imagery and aspects of language. It roves the universe; sees equivalences and similarities even across dimensions; resolves paradoxes; but is impatient with detail. For example analysts were still calculating the math of Einstein's work after he died. M S Livingstone, Sci Am 258, 78 (1988) researching eye processes realized some cell groups respond to detail, others to a whole image. When or if these two processes are discovered to initially interpret data separately then the ancient paradox of mind duality may be resolved. Configurations and details are glove and hand. The hope: understanding of wholes may replace out of context memorizing. Yet knowledge from insights is not absolute. Since Einstein proposed a theory about relativity in general seven decades ago, he and many others have been trying to improve on the generality. Intuition stretches only bounds of the conceptual fields within which each person resides.

QUESTIONS OF OPTIMATIZATION

With or without a convergence of views questions need confronting. Not only does each country compete in creating technology but each seeks to educate its youth maximally. In the past starvation of youthful intellect was done without computers. In the future will computers complement mind or simply out-manipulate brain? Developmental physiological data for body brain and mind is required. Psychological data is colored since we products of international behaviorist theories trace back to the turn of the century. But AI research has set new trends and risk-takers are stretching past presumptions.

Some questions facing technology and education are: 1) In general should learning be enhanced mainly in accord with physiological phases? Recall flashcards or computer toys for neonates up. Even the idealized Sesame

Street fun, abstract drills fail by inputting abstracts on sensory circuits. For thousands of years consumate teachers have known that mental development has stages. R W Thatcher, R A Walker, S Giudice, Sci 236 1110 (1987) have confirmed the two hemispheres develop alternately but details have not yet formed a clear picture. From observation I propose development from two years alternates in dominance about every year until six at which time there are two years of intuitive flow. The language-logic mode surges nine through eleven. Transition years are five, eight and twelve. From the twelfth year coordinating the two hemispheres proceeds unevenly taxing young teens to harmonize enlongating perspectives, arms and legs. Were these phases confirmed current curriculum could be digested during intermediate years.

2) In particular should the body have hands on experience before abstractions? Counting rods provide primary children with visual and muscular awareness and comprehension up to logarithms. The infamous d,b,p,q mix-ups happen primarily to children who are forced to write early. Mud pies, skipping rocks, teeter-totters and spinning swings aid mind maps as well as surfing. P van Sommers, Drawing and Cognition, self-reviewed in Psych Today 20, 62 (1986) confirms, "An analysis of drawing methods offers a microcosm of all the cognitive activities we perform in everyday life.... mechanics, strategies, representational forces, prosodics and personal style operate simultaneously even within the same stroke." Should scribbling or mechanical drawing be swapped for computer graphics? Is the paradox wherein technology erodes its own pool of experts resolvable?

3) Does developmental language as rhythm, flow and ideation need years of spontaneous expression and self-disciplined interchange with others before being inhibited by pedagogs or disrupted to type, spell and use rote language on computers at five years? Is emotional sharing during parent-child reading an incalcuable loss when story telling is left up to mechanicals as TV or tape-deck even when housed in teddy bears? If intuition and language-logic can be seen as two aspects of a mechanistic brain with synergy that is greater than each separately, mind comes into focus. AI through its creative experiments can validate intuition's role in intellect reforming 4,000 year old rote curriculum.

GEMNET: A GLOBAL COMMUNICATION AND INFORMATION NETWORK

* Wayne R. Jacoby

ABSTRACT

Today education has shifted. A person can no longer have all the information in his/her head. They need to know how to acquire the information, how to access and manage data. We are living in a time-accelerated era. Decision making time is shortened and only quick data access can allow future leaders to make wise decisions. Couple with this the increasingly interdependent nature of our world and the special communication and information skills needed to live in harmony with our neighbor, the need arises for a system such as GEMNET.

INTRODUCTION

GEMNET is a component of Global Education Motivators (GEM), a non-profit, U.S.A. based, organization, founded and operated by educators to promote world interdependence and education for life in a global society. An integral part of GEMNET is its computer network that allows the user to access a databank of global information services and to link in communication exchanges with other users to literally bring the world into your personal computer and/or classroom. People are resources of information through direct E-Mail communication and friendships are promoted. This direct interaction among users, linked often by interest, helps people of varied backgrounds to overcome cultural stereotypes and misunderstandings. GIST, GEMNET's Information Services via Telecommunication, gives direct access to global data bases. This data basically frees the individual from dependence upon interpreted, indirect sources of information about the world, and how that world views them; a better way to internationalize education.

FUNCTION OF GEMNET

GEMNET functions by means of sending and receiving information and messages from one computer to another using a microcomputer (or terminal), a modem (with connecting cable and card), communications software, and a telephone line. The GEMNET user can access a wealth of news and global information, and can send messages to schools beyond their community, even internationally - instantly, easily, and inexpensively.

---

* President, Global Education Motivators, Inc.

Students prepare their message off-line using the word processor on their computer. When the message is ready, a local phone number (usually) is dialed and connects with the Telecommunication Cooperative Network which houses the GEMNET system. Once on-line a simple security check is made to get the user directly into their account. Then the already prepared message can be sent. For example, it could be sent from Pennsylvania to England in less than one minute at a cost of less than 50 cents. E-Mail user exchanges nationally or internationally, can actually hold "live conversation" if wanted. If not communicating, the user could go directly into GIST to get information on foreign countries, current events, global data or other global education information.

GIST SERVICES

GIST has much educational value. The user can (through read, scan or search), research current happenings in 3rd World countries through the Global Information Network of Interpress. This service is strictly a development world news service with in-depth stories to make the user more aware of critical happenings in the 3rd World. The read, scan, search component of Interpress is also found in UPI and AP newswire stories, as well as special United Nations News features, updated daily, including U.N. agencies such as UNICEF, UNDP and UNDRO. All of this can be supplemented by other sources as well.

GIST also includes a World Countries Data Base with encyclopedic information on 178 countries and/or territories around the world, such as type of government, population and literacy rate. Another information source is Global Data Resources, where you can find up-to-date information on world population, food supply, energy and other important information about Spaceship Earth.

Also found in GIST is the unique United Nations Classroom. Developed by GEM's NGO representative to the Department of Public Information at the U.N., it focuses on a Topic of the Month, such as human rights, lists available resources, profiles U.N. personalities and contains important U.N. documents. Its major emphasis is on preparation for Model U.N. programs.

Another integral part of GIST is a resource bibliography on a broad range of global education topics. This compilation by experts in each area contains listings of material that may include background readings and books, curriculum units, audio visual materials and other global resources. Each item is listed with a description, what it costs and where to purchase it. The data base contains approximately 1,000 items.

Altogether there are more than 25 different data bases in the system.

THE FUTURE

As we look to the future, can we prepare students for anything less than what was addressed in the Abstract of this paper? I think not. Our world is rapidly changing and I am often reminded of a parable which I hope will not be a commentary on our future.

> Once upon a time there was a class
> and the students expressed disapproval of their teacher.
> Why should they be concerned with global interdependency,
> global problems and what others of the world were thinking,
> feeling and doing?
> And the teacher said she had a dream in which she
> saw one of her students fifty years from today.
> The student was angry and said,
> "Why did I learn so much detail about the past
> and the administration of my country
> and so little about the world?"
> He was angry because no one told him
> that as an adult he would be faced
> almost daily with problems of a
> global interdependent nature, be they
> problems of peace, security, quality
> of life, food, inflation, or scarcity
> of natural resources.
> The angry student found he was the
> victim as well as the beneficiary.
> "Why was I not warned? Why was
> I not better educated? Why
> did my teachers not tell me about
> the problems and help me understand
> I was a member of an interdependent human race?
> With even greater anger the student shouted,
> "You helped me extend my hands with incredible machines,
> my eyes with telescopes and microscopes,
> my ears with telephones, radios and sonar,
> my brain with computers,
> but you did not help me extend
> my heart, love, concern
> to the entire human family.
> You, teacher, gave me half a loaf." [1]

Education for tomorrow needs to contain many things. I believe what GEMNET has to offer can help empower students, teachers, administrators, ... everyone, to be better prepared for life in our globally interdependent world.

---

[1] By Jon Rye Kinghorn from A Step-by-Step Guide for Conducting a Consensus and Diversity Workshop in Global Education. A program of the Commission on Schools, North Central Association and the Charles Kittering Foundation.

THE APPLICATIONS OF TELECOMMUNICATIONS IN TEACHING/LEARNING SETTINGS AT THE SECONDARY SCHOOL LEVEL

Bruce Cates[1] and Norman Bell[2]

ABSTRACT

This project was designed to explore a variety of activities which potentially could make the teaching/learning setting of the secondary school more effective through the use of telecommunications. Laptop computers, the Tandy 102's, were made available by the Tandy Corporation, were assigned to students in an advanced computer applications class. In the first phase of the project the students were instructed in the use of the ROM-based text processor, and used the computer in the applications course as well as other classes in which they were enrolled. Printers were made available for them to produce hardcopies of their text files. In the second phase of the project, the students were instructed in the process of uploading text files through a null modem to a desktop computer for reformatting using a more powerful word processor. In phase three a bulletin board system was installed on a Tandy 1000 computer and the students were taught the processes of uploading and downloading files. In this phase the student would develop a paper and then upload it to the bulletin board where it would be accessed by the teacher. After reviewing the paper and writing editorial comments on it, the teacher would place it on the bulletin board where the student would retrieve it, modify it accordingly, and return it to the board for teacher review. Phase four of the project was an extension of phase three to other teachers in the system. Thus, in this project the students were given the opportunity to use recent technology in the development and revision of research papers. In addition, students discovered a variety of additional uses of the computers and the bulletin board system.

INTRODUCTION

With the increased availability of microcomputers able to communicate with each other through the use of telecommunications hardware and software, it became evident that it was important to explore the variety of ways that such capabilities could be used to enhance teaching and learning at the secondary school level. To this end, an ongoing project in cooperation with the Tandy Corporation was implemented at Carmel High School in Carmel, California. The immediate goal of the project was to determine the ways in which a laptop computer could be used in conjunction with a desktop computer on which an electronic bulletin board had been installed. The project was designed to be implemented in four phases, with each phase adding new capabilities for the students and the teachers.

PHASE ONE

The first phase of the project was to assign to each of the students in the school's advanced computer applications class a Tandy 102 laptop computer. Each of the students had completed a review of three basic applications programs: word processing, electronic spreadsheets, and a data manager program. In this first phase the students word processing skills were implemented on the ROM-based text processor built-in to the Tandy 102. As these skills were transferredto the laptop computers, the students began to use these computers to take class notes in the computer course and additionally in other courses being taken concurrently. Using the text processor the students were able to enter the information and then revise their writing by making additions, deletions, and corrections. Hardcopy in this first phase was produced by attaching the 102's to either dot matrix or daisy-wheel printers. General activity during this first phase, in addition to developing class notes, included essays and reports, and in one case notes for an oral presentation.

---

[1] Computer Instructor, Carmel High School, Carmel, California

[2] Professor, Michigan State University, East Lansing, Michigan

PHASE TWO

The second phase of the project was directed at instructing the students in the process of uploading their text files through a null modem to a desktop computer, the Tandy 1000, with a more powerful word processor. The software used for connecting the computers was the built-in communications program, Telecom, in the 102's and the Telecom application included in the DeskMate applications package on the Tandy 1000. Once the text files had been transferred to the Tandy 1000, the students had the opportunity to conduct more serious formatting using either the DeskMate Text application or PC-Write. Included in these advanced formatting capabilities were bold printing, centering, justification, and underlining. In addition, with the 80 x 25 screens on the Tandy 1000, the students were able to view much more of their file at a time and thus were provided with the opportunity for on-screen formatting.

PHASE THREE

In phase three of the project, the students were introduced to the operation of the bulletin board system. To prepare for the use of the BBS, students uploaded a communications program, Xmodem, to their laptops via the null-modem connection. The students then were instructed in how to prepare the data base files so as to contain the access phone numbers for the BBS and the procedure to follow in connecting their laptops to the phone lines at home in order to contact the BBS using Xmodem. In this phase the initial use of the BBS consisted of logging on the system
and leaving messages for one another in one or more of the available message areas. In teaching these procedures explanations were provided concerning the following topics: system operators, system security, passwords, BBS etiquette, and the use of commands for moving from one area of the BBS to another and storing and retrieving messages.

Also included in phase three of the project was instruction in the concept of file transfer on the BBS. The students' previous experience with file transfer using the null modem facilitated their learning of file transfer using the BBS. The students were then given assignments in class to practice the file transfer method, including some assignments in which they were to download files and then print them out in class. Such activities were used to prepare the students for subsequent transfer of files to and from other teachers in the school.

PHASE FOUR

Phase four of the project was devoted to bringing other teachers into the system. Initially, teachers having personal computers with modems were taught how to use their own telecommunication programs to connect with the BBS at the school. The students, using the laptops, would then write papers for those teachers and upload the textfiles to the BBS in a special file area that was accessible by their teachers. The teachers, using their own personal computers, would then download the papers and review them at home. After making suggestions for revisions, the teachers would then upload the papers and the comments to a file area accessible by the students. At that point the students were able to edit the papers as appropriate and then, using the printers in the classroom, produce final copy to be submitted to the teachers.

ADDITIONAL RELATED ACTIVITIES

As a result of the experiences using the BBS at the high school, some of the students have located phone numbers of other local BBS's and are using the laptops to log-on and participate in a widening range of telecommunication activities. In addition to connection with the BBS's and pass messages and files over the phone. Clearly the use of the laptops has extended beyond the computer classroom, and even the high school.

Programming activities have also been added to the curriculum for this computer applications class. For these activities, the laptops have added a new dimension to the subject. Usually a programming class is limited to the computers on hand in the classroom and for only the prescribed class time each day. With the laptops, students take their work home and solve problems by trying out their solutions before returning to class. Consequently students are more efficient in the use of the class time.

SUMMARY OF INITIAL FINDINGS

In order to gain insights concerning the effect of this project, those students were asked to keep journals and the teachers involved were asked to participate in interviews. Typical of the early student reports taken from the journal were: "I was really excited by getting it (the laptop). At first I got really frustrated, but now I am beginning to understand it more." As with any new materials there was a learning curve as the students became familiar with the procedures. With experience, the journal notes became more like the following: "I have tried using the Tandy in other classes and found that it was a lot easier to type than to write out the assignments" and "I've learned how to operate a modem and a little different way of problem solving through a different kind of logic." When asked to evaluate the computer and his use of it, one student commented, "I think that the Tandy's size is great. It is small enough to carry around and big enough not to lose. I really like the power I have to transport files, to communicate with other people over the computer." Another reported the laptop was "great for typing notes and rearranging them later. I took my laptop to the library and typed a bunch of stuff for a civics report out of the book that I couldn't check out. I also used it to type a draft of my physics lab report, which made a long project ten times easier."

In summarizing the students' comments, it appears that as the laptops became easier to use the students found more and more ways of using them. The effective results were in direct proportion to the amount of hands-on training the students received. As the more mechanical elements of teaching the procedures are now in place, a more formalized evaluation of the learning process will be undertaken with each new group exposed to the technology.

Related to the interviews done with the participating teachers, the comments of the first teacher involved typify the reaction of most. This teacher pointed out that this allowed him to work on papers at his leisure and at his own pace without having to take a lot of papers home. He felt that it gave students legible responses–answering a common complaint of students when work is returned by teachers. In addition, he pointed out that it opened up an electronic dialog between teachers and students. There could be multiple round trips of information as students responded to the teacher's comments. It was suggested that this system could also be integrated with a writing method where work by students is passed around within a group. Members of the group critique each other's writing. All members of the writing group would then benefit from each others' and the teacher's comments. The structure of the BBS at the school can easily be tailored to create such group areas. A teacher could be given access to all the group file areas while members of each group would have their own file area accessible only by students in that group.

PROPOSED FUTURE ACTIVITIES

As this is an ongoing and evolving project, there are additional elements in the early stages of development at this present time. First, there are efforts being directed at developing access to outside data base sources to augment research resources for students when they are preparing research papers. If students exhaust the library's resources they will be able to log on to a computer based information retrieval system where new and more current courses of information will be available. The end result will be papers based on more current research, and thus more accurate reports.

The BBS system is to be expanded to include more administrators and teachers. As the school staff become more comfortable with the system, it is expected that more lines of communication will be opened within the district, linking the schools that are spread out over a rather large geographic area. In conjunction with this proposed expansion, elementary and middle school students will be encouraged to learn about the bulletin board system as part of their computer education program. Students in classrooms with access to modems will be able to learn at an early age the process of sending and receiving messages and transferring files.

As part of the continuation and expansion of the system, research projects will be developed to assess the changes in behavior noted among the teachers and the students. A more serious effort will be undertaken to determine the effects of word processing upon writing, and the effects of the use of the bulletin board on teacher-student communications. Further, there will be focus placed on determining the various uses to which the bulletin board system is made between students and students, students and teachers, teachers and teachers, and teachers and administrators.

SUMMARY

It appears that the potential impact of this type of technology on learning both in and out of the classroom could be similar to that of the introduction of calculators and computers in the math and science curricula. With this system a tool is made available that promotes interactions, research, review and revision of writing, and an increased motivation to produce schoolwork beyond what is required to "just get by" to a level of work that a student is proud to share with other students and to submit to teachers in a variety of fields.

Establishing such a system within a school environment requires a combination of the proper hardware, software, and personnel. The time commitment to introducing such a system requires that there be a teacher or an administrator with sufficient interest to learn, monitor, and improve the system, and the supporting instructional modules designed to provide assistance in how to use the system, as problems arise. The importance of the personnel cannot be overemphasized. A successful program depends on the initial commitment of the school system and the assignment of capable individuals to get the program underway. Once the system is in place it is much easier to maintain, since less problems arise and students are better prepared to handle the system because of improved classroom instruction related to the use of the system.

ELEMENTARY SCHOOL COMPUTER LABS

Ronald S. Pelfrey*.

ABSTRACT

This report is a description of a process used by one school system to plan for computer labs for its elementary schools and how it used a diversified committee to develop a budget, secure a committment from the board of education, develop a comprehensive bid document, evaluate bids and begin implementation.

INTRODUCTION

Fayette County Public Schools, located in Lexington, Kentucky, is a district of about 30,000 students (17,000 elementary). The district has been in the midst of a process of planning for the implementation of computer instruction at the elementary school level for three years. When the district began planning in earnest during the 1984-85 school year, there was not an established base of computers at the elementary school level.

To develop a district computer plan, the superintendent appointed a committee comprised of teachers, administrators, university personnel, business leaders, lay parents and other members of the community who had expressed interest and concern about school board appropriations. To determine how to best proceed, the committee chair decided to take a seven step approach:

1. Assess needs and set goals
2. Develop a plan
3. Evaluate systems that meet the needs
4. Develop a working budget
5. Obtain a committment from the board of education to fully fund the committee recommendation
6. Develop a bid document that evaluates each component of the management system with an emphasis on software
7. Accept the highest evaluated bid and begin implementation.

ASSESSING NEEDS

The school district was experiencing increasing enrollment at the elementary school level at the same time that the state legislature began imposing class size maximums. Since we had determined that our recommendations would impact facilities, equipment (hardware and furniture), instructional programs, and personnel, we formed subcommittees to review information on each. The personnel subcommittee, for example, was looking at the best way of staffing the schools for the use of

* Mathematics Coordinator, Fayette County Public Schools, Lexington, KY

computers and of providing inservice training to teachers and administrators.

DEVELOPING A PLAN

By the beginning of the 1986-87 school year, the committee was ready to revise and finalize its plan. As the committee reviewed information from computer hardware and software vendors, districts with existing elementary computer programs, and published articles about computer education, four recommendations were made.

1. Buy only state-of-the-art technology. With the rapid changes taking place in the computer market, we felt it would be unwise to select hardware that was already behind technologically. We also decided to try to find technology that was upgradeable.
2. Purchase a number of computers per school that equals the maximum number of students per class. The original plan had called for one computer per fifty students. The elementary teachers on the committee believed that this would necessitate a pull-out program, which they felt most teachers would resist. The plan was revised to provide enough computers at each school for the state-mandated maximum class size (currently 29).
3. Select only quality software which includes an excellent instructional management system. Teachers cannot be expected to learn how to operate individual software programs as well as determine the best time to introduce the software into their instructional program. The committee also wanted software to offer instruction on higher order thinking skills and not just the simple drill-and-practice that a student could get much more economically from a workbook.
4. Keep staff burden to a minimum. The orginal plan had called for rotating certificated staff members between labs, but, as we talked to persons from districts with existing labs, we found that this was not the best alternative. We determined that the assignment of a classified staff member to each lab would insure that a knowledgeable person was on hand if there should be hardware or network problems. Moreover, since the lab attendant was a classified person, the classroom teacher would still have the responsiblity for the instructional program by bringing the students to the lab and staying with them during the entire computer lesson.

EVALUATING SYSTEMS

The 1986-87 school year was used to evaluate various computer assisted instruction systems. We felt that a good judge of the labs would be the Fayette County elementary school students themselves. So we asked vendors who had expressed an interest in participating in the bid process to provide fully configured pilot labs for the fall semester. Four companies chose to participate in this process. In the final bid evaluation, the two vendors who had not participated in the pilot lab venture were given an opportunity to make half-day presentations to the committee.

The committee believed that it was important that the ease of operation of the labs, the match of the software to the curriculum, the durability of the hardware, etc. stand the tests that could be provided by the ultimate end-users, the students. Kentucky also has a list of minimum skills for each grade level in mathematics and reading. The vendors were asked to provide a correlation of their software to the state minimum skills as well as to the local curriculum for mathematics and reading.

DEVELOPING A WORKING BUDGET

Each potential vendor was given a description of what would be in the request for bids. Each vendor would be requested to provide, for example, a networked lab of one host computer and twenty-nine student stations (each with color monitor and a minimum of 640K RAM), K-6 reading and mathematics software, synthesized and/or digitized voice, etc. The vendors were then asked to provide an oral estimate of the costs (purchase or lease) for one lab. These estimates were kept confidential but were used as the basis for determining how many labs could be bid with the available funds.

As the "unofficial" bids came in, we soon realized that nearly three times as much money would be needed as had tentatively been budgeted by the board. The initial budget had been prepared on the original plan, but as the plan was revised, particularly the need for enough computers in each school to support the maximum number of students in a class, the costs escalated.

Because of this cost discrepancy the superintendent asked the committee to reconsider its recommendation and explore other alternatives before preparing formal bid specifications. The committee had spent over two years by this time evaluating computer systems and approaches used by others around the country. We now felt that either we should implement a quality computer laboratory approach or else go without computers in the classrooms.

BOARD COMMITTMENT

Confident of our convictions, the committee prepared a report for the board and superintendent which stated why a comprehensive computer-assisted instruction program in a laboratory setting would be superior to any other computer instruction method.

From literature, discussion with other sites, and our pilot sites, we found that CAI was the best method to:

1. Provide individualized instruction in a consistent manner and of a consistent quality. Additionally, we found that the computer enabled us to provide individualized instruction without stigma.
2. Provide equal learning opportunities across the schools, grades, classrooms, and abilities.
3. Provide technology without negatively affecting an already overburdened teaching staff.

4. Provide comprehensive instruction that complements everyday classroom instruction. Individual floppy disk software or limited software series simply couldn't do this.
5. Provide cost-efficient computer instruction. Labs were preferable to other approaches because we had determined that we did not want a pull-out computer program.

In addition, we explained to the board that the CAI labs could provide solutions to several of the other priority issues which had been identified by the district in another task force, e.g., summer school offerings, evening programs, and supplemental instruction.

Parents and teachers of students in the pilot schools supported these findings by speaking out in favor of the labs. A member of the committee who had been a longtime critic of the board in budget hearings also spoke out in favor of the cost effectiveness of the labs. As a result of this presentation, the board agreed to a long-term committment to fund the labs and directed our committee to proceed with the requesst for bid for the first eight schools.

DEVELOPMENT OF BID SPECIFICATIONS AND BID ACCEPTANCE

In the formal bid request, we specified very closely what was required in terms of hardware capability, number of computers, memory capacity of each computer, type of curricula, record keeping, etc. The bid document broke the evaluation into three, nearly equally divided, major areas: costs, hardware, and software. In retrospect, we would recommend that more weight be given to the software.

We tabulated the results as a committee and prepared a detailed analysis of the strengths and weaknesses of each system (hardware and software) for the board. All vendors also received a detailed analysis of their own product. The board accepted the committee recommendation.

So far we have eight labs operating. Within the next two months we will add another seven labs. We expect to fully implement all of our labs within the next two years.

CONCLUSION

Computers will undoubtedly play a major role in the lives of most of our students. Therefore, we feel that it was not just important, but necessary, to accord a proportional amount of time and money to implementing technology as an instructional tool. The system that we selected for our elementary schools represents an attempt to give all of our students an equal opportunity to learn, to keep them interested in learning, and to make how they learn, as well as what they learn, useful to future learning experiences.

AUTHORING WITH PILOT: AN INTRODUCTION

R.J. O'Connor*

ABSTRACT

PILOT (Programmed Inquiry-Learning Or Teaching) is an authoring language developed in the early 1970s specifically for educational appplications. Since it is a language rather than an Authoring System, PILOT is capable of handling a wide variety of programming needs. There are about twenty statements in PILOT, each consisting of an operation code, a colon, and necessary parameters or text. PC/PILOT is a dialect intended for use in an MS-DOS environment. This Workshop will illustrate the various statements of PILOT and several utility programs found in the supplemental software, the Advanced Features Library. Special attention will be focused upon use of PC/PILOT as a integrating element in optical videodisc, CD/ROM, mouse, and other external device support.

PRESENTATION

The following features of PC/PILOT will be described and illustrated:

- PILOT Statements
- EZ Text Editor
- Macro Processor
- Graphics Image Editor
- Advanced Features Library
- Video Script Executive
- PILOT Special Interest Group

*Lehigh University, Bethlehem, Pennsylvania 18015 USA

Evaluating Computer-Integrated Learning Systems

K. Harris

Because of taxpayer demand for fiscal responsibility in our school districts and the desire of everyone to place effective learning tools in our classrooms, it is important that school districts know what to expect from current technology and what to anticipate in the near future. In 1985 while teaching in the public schools of Victoria, Texas, I began to investigate computer-integrated learning software. This study intensified as the Victoria school board directed the district to recommend software and hardware for two computer labs. These labs were to be one of the attractions at our two elementary school magnet campuses which were to open in the 1986-87 school year.

The Victoria school board narrowed our choices when it indicated that the two labs should offer integrated self-paced reading and math curriculum for grades K-5. While in the process of conducting the study, we learned to ask certain questions of the vendors. We also began to develop a list of what we considered to be critical factors in the successful operation of a networked lab in an elementary school and in the design of the software which was to be used within that lab.

We eventually were able to recommend Education Systems Corporation (ESC) software with a lab configuration that featured Tandy 1000 SX student stations and a Tandy 3000 HL as the fileserver. The effort to study before acting has proven to be quite beneficial. Victoria will have ten ESC labs on line in the 1987-88 school year.

Having gone through the process of study, implementation and operation of this rather specialized system, I can safely recommend that educators who are attempting to evaluate integrated learning software packages remember to do three things: Conduct an in-depth study of the lesson design, examine the capability and flexibility of the hardware, and observe the software management system in operation.

In terms of lesson design, expect the system to offer sophisticated branching capabilities thus enabling the program to branch from its current status based on student performance. This branching would include shifting the student to enriched curriculum as a result of superior work and offering varied instructional approaches for students who were obviously not mastering the skills being taught.

Juan Linn Math & Science Magnet School, Victoria Independent School District, Box 1759, Victoria, Texas, 77904.

There are many other lesson design priorities which educators should consider as they critique the lesson presentations. They should expect the lessons to offer various formats as they present material, ask questions, and offer responses for correct and incorrect answers. It is important to observe whether or not the questions can be answered without actually reading the lessons and whether or not the questions require critical responses. Educators must ask other questions such as - Did the lessons avoid offering cues which gave away the answer? Did they instruct rather than merely present material? Did each screen ask students to choose between at least two possible responses? Did immediate feedback precede the next item or question? Did the lessons generally avoid presenting full pages of text before calling for student response?

The relationship between the software and hardware offers a new arena of concern. Due to current technology there is no reason why we shouldn't be able to use graphics, high resolution monitors, and audio with a natural (human) sound to enhance instruction. It also seems fair that we require the use of a mouse thereby further developing an interactive atmosphere between student and curriculum.

The lab should also be flexible enough so that we can continue network operation using software other than that required for the integrated curriculum. We must also be able to use the student stations individually for other types of lessons and activities. There should be no reason why teachers can't have the lab full of students working on word processing, spreadsheets, data bases, BASIC, Logo, or any appropriate learning software. This also allows the lab to be used for after school tutoring, adult learning classes, and various types of summer programs.

An integrated curriculum should also have a comprehensive management system. Teachers and adminisrators must be able to receive information concerning student progress on an individual and classroom basis. If a district has labs in more than one school, it should be able to handle the information from a centralized location. This not only gives the district an overall view of student progress but facilitates the transfer of students from one campus to another.

It is not necessary that the lab require additional paperwork of the classroom teacher. However, the system should be able to allow teacher input whenever the teacher so desires. If the teacher wishes to intercept the established sequence of lessons by placing a student in a particular lesson this should not only be possible, but it should be easily accomplished. Sending students to work at unusual or unscheduled times should be no problem. A few commands on the fileserver keyboard should do.

Software companies which offer integrated learning packages should welcome input from the user. If teachers have lesson design ideas or complaints, the software developers must have not only the willingness to hear but the capacity to make lesson design changes.

Finally, speed is essential as lessons change during a session and when each lab reloads for the incoming class. When one class or one student stops, the next class or student should be ready to work within seven or eight minutes. Current CD-ROM capability will create higher expectations in this area.

Educators can expect these capabilities of the computer-integrated learning systems which they examine. If the vendors do not yet offer them, they soon will. The market will respond when educators know what they want. It is exciting to note that we had drastically lower expectations a few years ago. Since the technology is here, we would be foolish to expect anything less than what we know can be delivered today.

CADD LITERACY: An Introduction to Personal Computer based Computer Aided Drawing and Design.

Jimm Meloy

ABSTRACT

In six years, the Personal Computer (PC) has dramatically changed Computer Aided Drawing and Design (CADD). PC-CADD has evolved from automated 2D drafting to 3D wireframe, surface and solid modelling. CADD+ applications, including non-graphical attribution extraction, CAD/CAM (Computer Aided Manufacturing), finite element analysis, parametric design, simulation and technical documentation and presentations are also available on PCs. This workshop will review the current state of PC-CADD and CADD+ applications in the USA, including landmarks of PC-CADD, typical hardware and software configurations, examples of current PC-CADD and CADD+ software, future developments, ongoing concerns and educational considerations. A hands-on workshop may be available.

INTRODUCTION

Prior to 1982, CADD was available only on mainframe or dedicated turnkey computers. An estimated 140,000 (Ref 1) turnkey or intelligent workstations have been installed in the USA in 15 years, at a cost of $20,000 to $100,000 each. In 6 years, approximately 280,000 (Ref 1) PC-CADD systems have been installed at a cost of $2000 to $15,000 each. By 1990, PC-CADD is expected to dominate 90% of CADD technology (Ref 2).

The major reasons for the success of PC-CADD have been:

- 90% functionality of turnkey systems for 10% of the cost.
- ready availability of a standard and upgradeable hardware platform [IBM PC (or compatible)/DOS].
- non-dedication of hardware (can be used for word processing).
- hardware and software independence created by a free market.
- large selection of PC-CADD, CADD+ and third party software.
- large selection of PC add-on third party hardware.

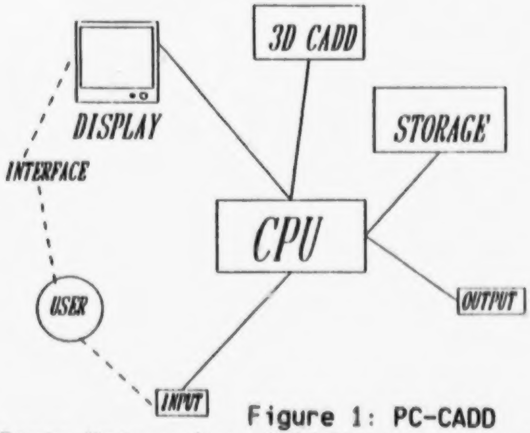


Figure 1: PC-CADD

Kent State University, 4314 Mahoning Ave NW, Warren, Ohio 44483, USA.

WHICH PC ?

All major PC-CADD software operates in the IBM PC / DOS (Disk Operating System) enviroment. 40% of PCs sold in the USA are IBM PCs, and 40% (compatibles, or clones) believe they are IBM PCs (Ref 3). The Apple MacII (12% market share) is not IBM PC compatible, but popular for desktop publishing. Almost all IBM PCs or compatibles are based on Intel 8088 (8-bit, 4MHz), 8086 (8-bit, 8MHz), 80286 (16-bit, 12MHz) and 80386 (32-bit, 20MHz) chips. For PC-CADD these computers are typically upgraded with a math coprocessor, hard disk, high resolution graphic card and monitor, mouse and a hardcopy device (Fig 1). Graphics cards, some with on-board Intel 82786 or TI 34010 processors, offer instantaneous hardware zooms, 2000 x 2000 virtual screens, and/or 32,000 simultaneous colours. Pen plotters have been supplemented by laser, colour thermal, inkjet and dot matrix printers, and film recorders. A typical professional level PC-CADD and a high specification PC-CADD configuration are given below:

TYPICAL PROFESSIONAL LEVEL PC-CADD CONFIGURATION

(Compatible with 95% of PC-CADD software: 1987)

8086, 80286 or 80386 CPU based computer (IBM PC Compatible), floppy drive, Intel 8087, 80287 or 80387 co-processor, keyboard, mouse, serial, parallel ports, 640KB+ RAM, DOS operating system, 20MB+ Hard disk and controller, EGA 256 KB (640 x 350, 16 colours), or VGA (640 x480, 256 colours) graphics board and monitor.

HIGH SPECIFICATION PC-CADD CONFIGURATION

80386 CPU based computer (COMPAQ 386/20 or IBM PS2/80 compatible), floppy drive, Intel 80387 or Weitek 1167 co-processor, keyboard, mouse, serial, parallel ports, 8MB+ RAM with caché, DOS and/or Unix operating systems, 40MB+ Hard disk and controller, 60 Hz non-interlaced (1280 x 1024, 256 colours) graphics card with Intel 82786 or TI 34010 processor and 19+" monitor.

PC-CADD SOFTWARE FOR DRAWING AND DESIGN

Early PC-CADD systems were used to automate the drafting process, and for preliminary layout design. In six years they have evolved from 2D through 2-1/2D to 3D modelling. Three model types are used, namely:

wireframe - in which the model is stored as a series of vectors.
surface - in which the model is stored as a series of surfaces
solid - in which the model is stored as a series of volumes.

Most PC-CADD software is wireframe. Some packages have an internal programming language (eg Autolisp, CADL) which offer extensive customisation. Some have open architecture, which have encouraged hundreds of third party software developers to add their specialisations on top of the CADD package, (especially AutoCAD), often generating large productivity gains. One current estimate of PC-CADD software market share is: AutoCAD 60%, CADKEY 15%, Versacad 15%, Others 10%.

PC-CADD+ APPLICATIONS

CADD is a graphical door into the greater world of CADD+ applications that are available on the PC. These include:

- non-graphical attribute extraction for estimating, parts lists.
- CAD/CAM (Computer Aided Design/Computer Aided Manufacturing).
- Finite element modelling and analysis for structural analysis.
- Technical documentation and presentation for manuals, etc.
- Facilities planning, including graphical simulation.
- Parametric design for standardised components.
- CIM (Computer Integrated Manufacturing) for the integration of engineering, manufacturing and business functions.

LANDMARKS IN PC-CADD

1980	8088 8-bit chip PCs with low resolution graphics available
1981	Mouse, digitizer input and pen plotters already available
1982	8088 based 2D wireframe computer aided drafting (AutoCAD)
1983	Early CADD+ applications: attribute extraction, eg BOM.
1983	Hard disk storage, high resolution graphics available
1983	80286 16-bit chip PCs available
1984	3D wireframe computer aided design, including perspectives
1984	CADD+ application: CAM (Computer Aided Manufacturing)
1985	CADD+ application: Finite Element Analysis
1985	3D surface modelling
1985	CADD+ application: Parametric design
1985	Optical storage, 3D input available
1986	CADD+ application: Simulation
1986	80386 32-bit chip PCs available
1986	High resolution graphics with dedicated processors available
1987	3D solid modelling
1987	Over 800 PC-CADD or CADD+ application programs available

FUTURE DEVELOPMENTS (NEAR TERM)

- Reduction in costs, increase in processing speeds.
- Operating system to replace DOS, O/S-2 or UNIX ?.
- Greater mass storage options, WORM, CD-ROM, etc.
- Hardware graphics manipulations with chip-on-board.
- More use of color hardcopy for 3D representations.
- 3D input devices.
- Improved user interface.
- Greater Analysis and CAD/CAM integration.
- Greater use of knowledge based systems.
- Greater prominence of solid modelling.

ONGOING CONCERNS

- Standards for presenting 3D models, eg curved surfaces, screwthreads, hidden details, centre lines, etc.
- Standards for consistent data exchange between systems, IGES, DXF, etc.

EDUCATIONAL CONSIDERATIONS

- Typically, prior to PC-CADD, training was done by turnkey vendors. PC-CADD is distributed in a different manner; it is sold as a PC application programme. Only 13% of PC users receive formal training (Ref 4). There is a opportunity for Educational Institutions to act as CADD training centres, as well as CADD education centres, offsetting costs.
- PC hardware is non-dedicated and can be used for non-CADD applications, for instance word processing, and by different departments within an institution.
- PC users are hardware and software independent.
- Hardware and software is readily upgradeable.
- Lower cost per seat than turnkey systems; more seats / $.
- Some PC-CADD companies currently have very active education departments and advantageous sponsorship programs.

DEMONSTRATION / WORKSHOP

Examples of current PC-CADD and CADD+ software which may be shown include:

Wireframe Model - AutoCAD, CADKEY.
Surface Model - Autoshade.
Solid Model - The Engineer Works, Solid Synthesis.
Finite Element Analysis - Algor Supersap.
Technical Documentation and Presentation - Kinetic.
Graphical Simulation - Cinema/Siman.

REFERENCES

1. C.Machover, MICROCAD TRENDS - 1980/1990, 5th International Forum on Micro-Based CAD, North Carolina State University, September, 1987.
2. T.Wohlers, CADD on a PC, Colorado State Univerity, October, 1987
3. Storeboard, Infoworld, November 30, 1987.
4. V.Brown, International Data Corp, Computer Systems News, Dec 1987

FROM KINDERGARTEN TO INFORMATION SYSTEMS (Workshop)

Raul Dorfman*

This presentation reports on a methodology for learning and teaching systems. Information Systems, Computers and Structured Programming are introduced with a systemic approach.

Workshop focus:

- System Curriculum and the Elementary School.
- SYSTEMANDI a practical tool for complex systems analysis and synthesis.
- Sensory motor frame of reference for General Systems vocabulary.
- Sensory motor approach to structured algorithm analysis and synthesis.

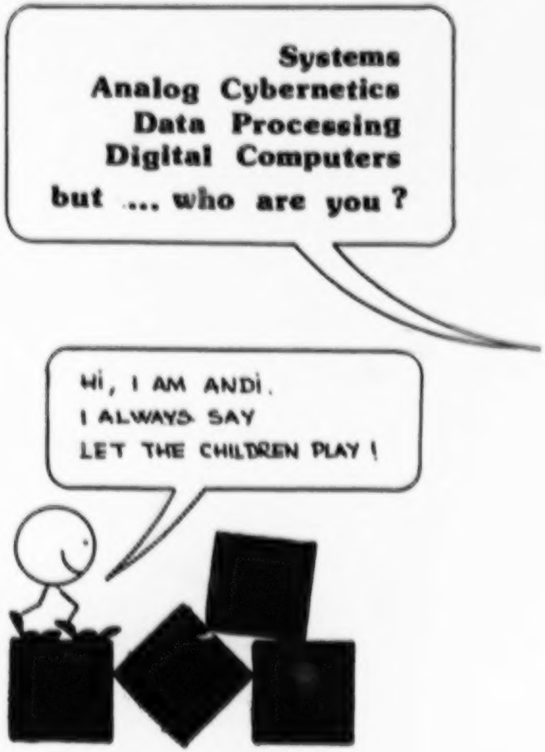
Constructing and playing ANDI's games allows to introduce system analysis and synthesis in the elementary school (K-9).

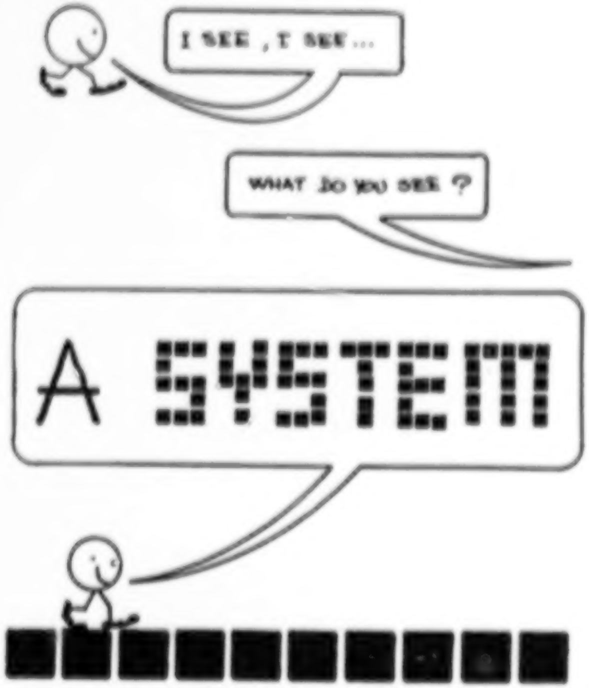
Workshop support materials:

- Solid Blocks
- Music Sheet and Tapes
- Textbook (See Appendix 1 , page sample)
- Teacher's Guide, Slides, Transparencies.
- Videotapes
- Software examples

A draft of an interdisciplinary semantic net is presented (Appendix 2) for analysis and discussion. Marked with (K) are the concepts developed for Kindergarten. The word SYSTEMANDI is formed from the words System , Analog and Digital. For details on SYSTEMANDY please see reference 1, for field experiences reference 2, for theoretical background and bibliography reference 3. for the semantic net references 4 & 5.

*International Consultant. Estomba 2020, Buenos Aires, 1430, Argentina.
Society for General Systems Research, Argentine Chapter, GESI.


Systems
Analog Cybernetics
Data Processing
Digital Computers
but ... who are you ?
HI, I AM ANDI.
I ALWAYS SAY
LET THE CHILDREN PLAY !


I SEE, I SEE...
WHAT DO YOU SEE ?
A SYSTEM

APPENDIX 2

SYSTEMIC SEMANTIC NET

Aleatory
Ambience
Amplifier
Analog
Analysis
And (K)
Artificial
Autonomy

Backward (K)
Balance
Binary
Block (K)

Chaos
Clock
Closed (K)
Code
Column (K)
Complement
Complex
Computer (K)
Communication
Connector (K)
Conversor
Cybernetics

Data
Deduction
Deterministic
Delay
Derivate
Differentiate
Digital
Discrete
Down (K)
Drain

Efficiency
Element
Emmiter
Energy
Error
Etymology
Evolution
Exclusive

Feedback
Flow
Form
Forward (K)

Gradient
Goal (K)
Go (K)
Go To

Horizontal

If ... Then ...
... Else ... (K)
Inclusive
Input (K)
Information
Integration
Interactive
Interruptor
Interval

Language
Left (K)
Line
Logic

Matter
Memory

Natural
Net
Noise
No Go (K)
Not

Object
Observer
Operator
Or (K)
Order
Organization
Output (K)

Open (K)

Parallel
Perception
Perspective
Plane
Point
Probability (K)
Process
Proportional
Program
Ponder

Reference
Regulator
Repeat Until ...
Reserve
Right (K)
Rythm (K)

Semantic
Serial
Sequence
Structure
Synthesis
Source
System

Technology
Transdisciplinary
Transduction
Transmission
Up (K)

Valve
Variety
Vertical (K)
Volume

While ... Do
Work

REFERENCES

1. R. Dorfman, Microcomputer Applications in Education and Training for Developing Countries,Westview Press National Academy of Siences,USA,1987,p 169.
2. R. Dorfman, A. Monti, Proceedings of the International Symposium on Informatics and Education (Tucuman, Argentina, 1983) pXVIII.
3. R. Dorfman, Del Jardín de Infantes a los Sistemas de Información (Ministry of Education,Argentina,1984).
4. Robbins, S.S.,T.A. Oliva.,Behavioral Sciences,Col.27, 1982,p 377.
5. Ferdinand de Saussure, Curso de Linguistica General, (Planeta-Agostini,Madrid,1985) p93.

Note: ANDI, SYSTEMANDI, PROGRAMANDI and "From Kindergarten to Information Systems" are copyright Raul Dorfman.

Workshop support materials

TWO PROMISING NEW APPLICATIONS OF TECHNOLOGY FOR IMPROVING PARENT INVOLVEMENT

J. P. Bauch~.

ABSTRACT

When parents are actively involved in the education of their children, it has been shown that there are positive effects on the children, the family and the school program. However, most methods of parent involvement place large time demands on both parents and teachers. A model using computer-based calling from the school and telephone answering machines in teachers classrooms has been developed at Vanderbilt University. The model can increase school/home interaction and put parents in direct contact with their child's classroom on a daily basis.

BACKGROUND

Excellent communication and a partnership relationship between school and home has been an ideal as long as schools have existed. Parents expect to know what is happening to their children in school, and teachers know that the influence of the home on the child is powerful. The traditional methods that have been used for parent involvement only work well for certain groups of parents, and have become so diverse that they may be unrelated to the primary purpose of the school; the education and development of the student. Busy teachers and busy parents have difficulty exhanging important information, and most efforts to improve the situation require major committments of time and energy resources.

THE PROBLEMS

There are several categories of problems that reduce or prevent genuine parent involvement. First among these is the lack of information shared between school and home. Only about 25% of parents with children in the public schools report that they are well informed about local schools (ref 1). In a survey of more than 1,200 parents of elementary school students, Epstein (ref 2) reported that many parent receive few or no communications from the school that are directly related to the learning activity of the child.

~Professor of Education and Director of the Betty Phillips Center for Parenthood Education, Box 81, Peabody College of Vanderbilt University, Nashville, Tennessee 37203.

A second problem area is the lack of preparation that teachers receive in parent involvement. It has been estimated that fewer than 20% of the teacher education programs in the United States require specific training so that teachers can implement good parent involvement programs. More than 30% of college professors in a multi-state survey reported that there was little or no emphasis on teacher/parent relationsips in any of their courses (ref 3). Another set of problems originates from the circumstances of parents themselves. Economic conditions and changing family structures are absorbing the discretionary time that parents might spend visiting the school or attending meetings. The gap between school and home is recognized, but functional solutions have not been readily available.

ARGUMENTS FOR IMPROVED PARENT INVOLVEMENT

James Comer has recently written "Nothing is more important to success in schools than the quality of the relationships between and among students, teachers, and parents." (ref 4). The National Governors' Association concluded that increased involvement of parents is vital to higher student achievement (ref 5). T. H. Bell, former U.S. Secretary of Education, placed high priority on active participation of parents in the education of their children (ref 6). This official theme continues with the present Assistant Secretary of Education, who cites the importance of parent participation and recommends that schools take the necessary steps to see that parents are informed and involved (ref 7). A body of literature has also been growing to support these recommendations.

There is no longer any question about the effectiveness of good parent involvement during the first years of schooling. The major longitudinal studies of early education all indicate that parent involvement can account for a significant part of the academic gain from early intervention (ref 8, 9 & 10). These studies show that the parents also change, increasing their aspirations and expectations for their children. Consensus has been growing for more than ten years that when parents are involved in their childrens' education there is will be a positive influence on both student achievement and student social development (ref 11, 12 & 13). The consistency of findings in favor of parent involvement as a contributing factor to achievement is high, and has led Moles (ref 11) to conclude that more school programs are increasing the communication between school and home as a means of improving student achievement.

Another category of information that favors parent involvement is the "effective schools" literature. In a study of the 212 public elementary schools selected by the U.S. Department of Education Elementary School

Recognition Program in 1986, one of the "themes" that was related to school excellence was that the schools shared in a collaborative relationship with parents and the community (ref 12). Using a random sample of 50 elementary schools chosen from a total of 636 school in the United Kingdom, Mortimore and Sammons (ref 13) identified 12 factors that distinguish effective schools from less effective ones. One of the 12 factors was parental involvement, which had a positive influence on the progress and development of the children. In Comer's research (ref 1) with two effective schools in New Haven, Connecticut, he found that increased communication between parents and teachers increased community support for the schools among parents and the community. The two schools went from being at the bottom in student achievement to within the top five of all schools in the system, and Comer attributed this dramatic change to improved parent involvement.

TECHNOLOGY APPLICATIONS

By combining computer-based telephone calling from the school and telephone answering machines in teachers' classrooms, the information flow between school and home can be multiplied by factors of two or three. In the classroom, the teacher makes a recording at the end of each day that summarizes homework, classroom activities and suggestions for parents. The recorded message can be accessed by parents from any phone at any time, and parents can also request that the teacher return a call if they want a direct conversation. This component gives parents daily information about their child's learning experiences, and the machine delivers the messages after the teacher has gone home for the day. (Messages to the teacher can be retrived remotely from the teacher's home phone, or the teacher can hear "call back" requests at the beginning of the next day.)

The use of the answering machine component takes no more than 5 minutes of teacher time, and most messages are less than one minute in length. By calling the number and hearing the teacher summarize the day, the parent can monitor homework, arrange other learning experiences, and assist the child.

The computer calling component uses a digital voice card installed in the school's office computer (IBM-compatible) and a sophisticated software program called CompuCall*. A teacher or administrator can record a message and have calls made to students' homes. The system can store and manage up to 99 different messages and match messages with specified subsets of students. All families might receive a reminder about an upcoming parent meeting, or parents of children preparing for a field trip may receive a message about the schedule. The CompuCall file management allows the operator to select or merge student list with ease, and the system can be set to call between certain time parameters. Records are kept on calls completed, busy, or no answer responses. The results of the calling cycle can be reviewed on the screen and/or printed. Since the system can complete between 60 and 90 calls per hour, large numbers of families can be reached efficiently at virtually no cost beyond initial installation.

These two components can also be used together for parent education. Tips for helping children with homework can be recorded on the answering machines, and parents can be reminded to call for the information by CompuCall. The use of these components can reduce routine communication time, increase the number of parents contacted, give the parents direct and daily access to school information, and improve the relationships between home and school. The model is not designed to replace direct communication, conferences, meetings or other methods for involving parents but rather to increase efficiency without extra time demands on busy parents and busy teachers.

REFERENCES

1. A M Gallup & D L Clark, Phi Delta Kappan, 69, 29 (1987)
2. J L Epstein, Report #346, Ctr for Social Org of Schools: Baltimore, MD (1983)
3. J T Stallworth, A Survey of Teacher Educators on Parent Involvement in the Schools (SWEDL, Austin, TX, 1984)
4. J P Comer, NEA Today 6, 34-40 (1988)
5. R D Lamm, Phi Delta Kappan 68, 212 (1986)
6. T H Bell, Leadership for Reform and Renewal of American Education (Nat Forum on Excellence, Indianapolis, IN, 1983)
7. C E Finn, Ed Leadership 44, 11-13 (1986)
8. I Lazar et al, Lasting Effects of Early Education, (SRDC Monograph #194, 1982)
9. S W Gray, Three to 20: The Early Training Project (University Park Press, Baltimore, 1982)
10. D P Weikart, Changed Lives: The Effects of the Perry Preschool Program on Youths Through Age 19 (High/Scope Press, Ypsilanit, MI 1984)
11. O C Moles, Ed Leadership 40, 44-47 (1982)
12. Research for Better Schools, ASCD Update 30, 8 (1988)
13. P Mortimore & P Sammons, Ed Leadership 45, 8 (1987)

* CompuCall is a trademark of Associated Computer Technologies, Inc., 3236 N.W. 27th Ave., Gainesville, Florida 32605.

Teaching and Learning Styles: A Self Assessment Workshop

M.K. Minter*, R. L. Minter**

ABSTRACT

The overall goal of the workshop is to stimulate participant's sensitivity to learning styles and the degree to which they influence teaching styles in classroom instruction. Participants complete two self-assessment inventories to determine their individual learning and teaching styles. Participants also have an opportunity to discuss their inventory profiles in small groups. Each small group presents a summary of their perceptions to questions on learning and teaching styles. Workshop facilitators provide a written composite report for all participants as a post-workshop feedback mechanism.

INTRODUCTION

The workshop has been previously conducted for four different higher education faculty groups within the U.S.A. An advantage of presenting the workshop to a faculty group NOT from the U.S.A. is to compare self-assessment data from different cultural perspectives. Two questionnaires are used: a Learning Styles Inventory (LSI) developed by D.A. Kolb (ref 1) and a Teaching Style Questionnaire (TSQ) developed by M. K. Minter. The composite of results from this international conference will be provided to all workshop participants and will compare the U.S.A. data with the data compiled from the Edinburgh, Scotland group.

OUTLINE OF STUDY AND METHODS

In this exploratory stage of research, the authors use a consistent design as outlined below. In each workshop participants are asked to: (1) write their first thoughts on learning and teaching styles BEFORE the workshop actually begins; (2) complete the LSI without any pre-explanation as to the theory and results by its author, D. A. Kolb; (3) interpret the inventory score and review the theory behind the LSI; (4) complete the short TSQ to stimulate thinking about commonly-used or preferred teaching/instructional methods; (5) engage in small group discussions to allow for interaction and sharing of ideas about learning and teaching styles common and specific to all academic disciplines. Throughout the workshop, care is taken NOT to defend the self-assessment instruments, but rather to stimulate thinking about one's own learning and teaching habits.

A significant learning device built into this workshop design is the post-feedback provided in the composite report sent to each workshop participant. This report provides synergetic, follow-up information which can aid particpants in recognizing how their learning and teaching styles relate to other faculty members in their collegiate group and to those from different cultural environments.

RESULTS

Based on the four faculty groups who have participated thus far in this exploratory workshop design, the results indicate certain trends. For

---

*Faculty Development Coordinator, University of Michigan-Dearborn, U.S.A. 48128.

**Dean, School of Management, University of Michigan-Dearborn, U.S.A. 48128

example, based on Kolb's LSI (ref 1), the scores are discussed in light of four learning dimensions: the accommodator, the diverger, the converger, and the assimilator. According to participants' replies to the Kolb inventory, there seems to be a trend toward individuals having a primary learning style. In general, the results of small group participation on learning styles suggest that faculty members perceive ALL learning styles to be applicable to ALL disciplines; however, some disciplines seem to require more of some learning techniques than others. The implication seems to be that awareness of needs inherent in different academic studies is desirable and flexibility in adapting to different learning situations will aid in the learning AND teaching processes.

Past results of the TSQ (Teaching Styles Questionnaire) indicate a preference for the lecture method. The major factors determining the use of the lecture seems to be (1) a large number of students in a class and (2) a large amount of content to be "covered" within a given amount of time.

Corresponding to the preference for the lecture method, the predominant materials used tend to be textbooks, readings, and handouts. Student involvement activities tend to be de-emphasized with the lecture method. Institutional environment factors also appear to be significant in influencing the style of teaching. The administrative climate of the institution seems to affect classroom climate.

In general, the small group results on teaching styles indicate that faculty members perceive teaching styles to be largely based on methods of instruction and classroom management techniques applicable to the subject being presented. The emphasis seems to be on the use of the teaching skills which are transferable to all disciplines; e.g., assessing student needs, setting realistic goals and objectives, planning, organizing, and on-going evaluation (feedback to students).

IMPLICATIONS FOR FUTURE STUDY

With the opportunity to share this workshop design with a faculty group representing different international backgrounds, the facilitators can gather data to compare and contrast with data from U.S.A. faculty groups. Key questions for the international group and future study are: (1) what learning-teaching style elements are common among professional/higher education teachers regardless of academic specialization or cultural background?; (2) What discipline-specific learning-teaching style elements are relative to a particular academic discipline?; (3) What instructional development needs can be identified from one's learning-teaching style profile?; and (4) How does an instructor's learning style relate to his/her teaching methods and activities?

ACKNOWLEDGMENT

Financial support for the Self-Assessment Workshops has been provided, in part, by The University of Michigan-Dearborn's Campus Grants Committee.

REFERENCES

1. D. M. Smith and D. A. Kolb, User's Guide for the Learning Style Inventory (McBer and Company, Boston, 1986).

FIFTH INTERNATIONAL CONFERENCE ON TECHNOLOGY AND EDUCATION

Edinburgh 29-31 March 1988

PLUTO - a European network for teacher education

Rhys Gwyn, Centre for Information Technology and Education,
Manchester Polytechnic (UK)

Norman Longworth, IBM International Education Centre,
La Hulpe (B)

SUMMARY

This paper describes an innovative network project currently being implemented by Manchester Polytechnic and other European institutions with support from IBM.

The network links together classes in initial teacher training institutions in a (growing) number of countries. It is based on the active collaboration of an existing person network, all of whom have extensive experience, at the European level, in the training of teachers to work with the new information and communication technologies.

The paper defines the overall thrust of the project as an experiment in shared development, at the European level, in the new field of collaborative distance learning; it is seen as a prototype for possible new forms of educational structures. In addition to describing project goals and modalities, the paper also identifies some of the practical issues which have to be faced in setting up such a network.

Appropriate Conference themes are: Open and Distance Learning, Teacher Education, Networking, Leadership (New Strategies for International Co-operation).

FIFTH INTERNATIONAL CONFERENCE ON INFORMATION TECHNOLOGY AND EDUCATION

Edinburgh 29-31 March 1988

PLUTO - a European network for teacher education

Rhys Gwyn, Centre for Information Technology and Education,
Manchester Polytechnic (UK)

Norman Longworth, IBM International Education Centre,
La Hulpe (B)

PROJECT BACKGROUND

The PLUTO Project, currently in its early operational stages, is a networking project which links together institutions of initial teacher education in a number of European countries. Since the Project is in its early days, the precise number will have grown between the writing of this paper and its presentation, but the current target is to establish the involvement of up to eight countries by the summer of 1988; at present participating countries number four. The Project is directed from the Centre for Information Technology and Education at Manchester Polytechnic and is supported by IBM at both European and national levels; other sponsors are in the process of becoming involved as other institutions formally join the Project.

(Our comment on the writing of this paper in fact holds throughout, in the sense that, by the time the paper is delivered, there will be a number of further developments to be reported.)

The Project builds on the existing collaboration between a group of teacher educators all with responsibility for the training of teachers for the educational uses of the new technologies of information and communication (NICT); all have many years of experience in this field within their own countries and at international level. It seemed appropriate, to members of this group, to set up a project which would enhance understanding, in the teacher training community, of the added values which new communications technologies can bring to the classroom, and develop, in trainers and in future teachers, the skills required to exploit the educational potential of these technologies. But the Project is more than just an enhancement of existing practice: it is seen also as a valuable opportunity to develop understanding of the new forms of teaching and learning - in this case, shared development and collaborative distance learning - made possible by the NICT. The formal Project statement expresses the point in the following terms:

"These skills will be developed through a range of collaborative projects which will involve shared activity between classes in the different networked institutions. In this way, the PLUTO Project will

- suggest new curriculum approaches to existing subjects,
- explore and identify ways in which the use of the technologies may enhance the resources traditionally available to the classroom, and
- possibly initiate new thinking about institutional delivery systems for education.

In these ways, the PLUTO Project will throw valuable light upon the models of school which may need to be examined as we move towards an education system for the twenty-first century."

In this statement, the PLUTO team expresses its firm belief that the Project offers valuable and essentially practical insights and intuitions into the long-term importance of the NICT for education and training.

II. PLUTO OBJECTIVES

In respect of objectives, the formal statement continues: "Within these overall goals, and with a focus on the teacher education sector, the Project will target on specific objectives.

First, it will help trainers and students to develop practical skills in

- the uses of information processing (databases, spreadsheets, text-processing),
- using and creating screen-based information systems such as viewdata (videotex),
- creating and using bulletin boards designed for educational purposes,
- using modern communications technology, particularly electronic mail and electronic file transfer,
- using desk-top publishing packages.

Of these, the third is the key to the skills specific to PLUTO. In each of the areas, the emphasis will be upon the use of software and hardware at recognised international industry standard levels.

Second, in respect of pedagogy, the Project will

- develop understanding of the classroom potential of such applications,
- provide trainers and trainee teachers with practical experience in the creation of classroom activities which exploit this potential,
- provide opportunity for the creation of support materials for those activities.

Third, in respect of feed-back, the Project will foster and monitor the kinds of learning that may be facilitated by the new technologies through the active collaboration of classes physically remote from one another and in countries foreign to each other, but which can act as resources for each other's learning.

Fourth, it will incorporate a specific focus upon new approaches to the acquisition of modern language skills which can be developed through direct class and individual links based on the immediacy of electronic network use.

In each of these areas, the project will seek to develop the expertise of the trainers of teachers as well as of student teachers and teachers in service."

In these ways, then, the PLUTO Project seeks to meet both the technical and the educational objectives which serve the overall goals of the Project.

III. NETWORK ACTIVITY

To enable this development to take place in a real context, it has been important to start from a picture of network activity. This is seen as an essential ordering of priorities; it would be all too easy to start with a focus on obtaining hardware and on getting a carrier system established and then to ask 'and what shall we do with it?' Therefore the first questions addressed were: 'what might we do if we had such a network available? what would be the educational rationale for going down this road?' It seemed essential to establish at least a broad-brush answer to these questions as a pre-requisite of a decision in principle to go ahead with the project.

In defining an answer to these questions, we have had to be sensitive to the danger of a prescriptive approach. One of the principles underlying PLUTO is that it should be open to activities stimulated from within the network - and by students as much as by staff - once it is established. Nonetheless we needed clear target activities as a starting focus, and careful discussion of the possibilities took us to the following broad agreement.

We started with a number of assumptions, which included the following:

- PLUTO was to have a real educational purpose, and was not to be just a chat facility,
- activity should take advantage of the international dimension of the Project,
- those involved would be working across linguistic barriers - and, while recognising the realities of international communication, we specifically wished to avoid imposing the use of English on all participants,
- there should be real outcomes od the network activity, usable by others,

- lastly, the network should be transparent in its operation so far as users are concerned, regardless of what technical issues might have to be faced in setting up the network.

This last point is important. The educational responsibility of those involved in PLUTO includes the training of teachers who are not specialists in computing or communications per se, but who are interested to learn how the NICT can serve as viable educational tools. What PLUTO needed to be, as soon as possible, was a system that could be seen, by the non-specialist, to work smoothly.

On the basis of these assumptions we arrived at a notional first activity, and this is offered here as an illustration. It is typical that the training of both Primary and Secondary teachers includes what we may broadly call study of the environment. This can take many forms: in Primary teacher training, for example, it would incorporate measurement of weather data, study of pollution in rivers, or the building up of a picture of the shops and services in a chosen environment - all activities which the novice teacher would later replicate with her classes. Out of thinking about such existing activities there grew the picture of a very simple first PLUTO activity, a shared exercise in which students in linked classrooms, in different countries, establish personal links, work to an agreed database and/or spreadsheet format, to gather data from their own environments. Once the processses inherent in this activity have been understood and mastered, they then exchange that data electronically with each other for purposes of comparision - and for the purpose of learning about electronic mail.

The picture, we readily acknowledge, is a simple one, but it achieves a number of Project goals. It establishes real links between real people. It reinforces existing classroom work related to the study of the Environment and the use of computer resources in that area. It provides the opportunity for students to engage with comparative studies, setting their own findings against those of others. And specifically, it allows them to develop skills in the use of electronic communication as a resource for education.

The potential of spreadsheets is especially interesting. They are, in their nature, suited to the manipulation of numeric data, and are therefore suitable, for example, for the measurement work associated with the study of, say, atmospheric or river pollution. But because the data is numeric, spreadsheets also minimise the natural language element in data exchange. Thus there emerged the notional picture of a first PLUTO activity, in which students engage in data collection to a shared spreadsheet format, exchanging data files which can then appear on-screen in the receiving country with labelling in the appropriate language. For this to happen, of course, there has to be natural-language communication in the first place to agree the activity and the format. In the first instance, the language of this dialogue will be English, but we felt that this was the nearest we could get to the spirit of Europeanism within PLUTO. We should add also that the process of defining any given PLUTO activity will involve tutors and students equally; it would be foreign to the spirit of the Project to have tutors merely instructing students as to their role.

If we see this as the basic PLUTO pattern, of collaborative activity to a shared format, then it will be seen that the approach is capable of considerable flexibility and expansion. Activity started, in fact, with a four-way link between Manchester Polytechnic, Zahle Seminarium (DK-Copenhagen), the University of Minho (P-Braga) and the University of Falun-Borlange (SW), but once an activity is established, it is possible for other classes to link in, even at a later date. The data gathered remains viable and can be made available for others to use, at any time; indeed, in the case of an activity such as the study of pollution, it makes sense for successive year groups to undertake the same studies and to monitor data for change. Thus we see PLUTO as building up a cumulative resource which many students will be able to use.

Exchange of numeric data is only a part of the PLUTO scenario. Other activities include, for example, database work, initially in the field of 'perception studies' in Geography, which starts from students' perceptions of each other's countries and proceeds to exercises designed to enhance what may well be superficial knowledge. In all of this, the emphasis on process is important. It is not sufficient that students acquire scraps of information, rather they must learn the processes of building up a meaninful picture of a foreign environment, of establishing the questions to be asked and the ways in which the data obtained may be interpreted. At the same time they learn other processes, notably of using communication technology of course, but we hope something more: the hope underpinning PLUTO is that, by using this network, future teachers will acquire understanding of a whole range of possibilities of creating opportunities for learning over physical distance and across national boundaries. The prospect is an exciting one.

The scope for language work is of course considerable in a European project of this dimension, and this element will be introduced at an early stage; indeed, the use of telecommunications for foreign language learning will have a high profile in the total PLUTO activity. Again, the emphasis will be on collaborative work, involving students in learning from each other by exchange and mutual correction of texts. A natural extension seems to be the use of desk-top publishing packages, the thinking being that the different classes can act as each other's 'foreign correspondents' for class journals, with the content emphasis very much upon the situation of teachers in training in the different countries. We see this kind of collaboration leading into students' work in schools with pupils at Primary and Secondary levels.

A more ambitious - in at least the technical sense - approach to language work is through the use of viewdata simulations. A number of such simulation packages are already in use in the UK on stand-alone micros and have proved to be a valuable tool in teacher training. The possibility of installing a similar facility on the network is under active review. If this proves technically feasible (and we know that it is on at least one potential carrier) then each participating institution will be allocated its own area in which to create a hierarchy of pages on the simulation; all users, of course, will be able to view all pages.

The foregoing illustrations are only very brief examples of the applications planned for PLUTO. What is extremely important is that the list should not be seen as prescriptive, but that a management style be evolved which will allow for monitoring of what goes on (since we need to know how the whole thing is working) but which will also allow participating institutions to develop their own ideas, some of which will involve two- or three-way collaboration, while others will be whole-network activities. We anticipate that the bulletin board will play an important part in the overall management strategy.

All of these ideas are easily recognisable in that they are based on known practice; we are guided by the old motor industry adage that a sensible innovation strategy is to change either the body styling or the engine, but not both together. Thus the innovative element of PLUTO lies in the structured international networking approach; its firm base is its link to existing teacher training practice. But, as we have said, PLUTO does in fact anticipate the possibly new forms of access to learning which we expect to see emerge within the mid-term future, and we have some ideas, in embryo form, about quite new forms of learning activity which might be created within a PLUTO-style network.... for these, however, it is as yet early days.

We also mentioned school-based work in the context of teacher training. There is an additional dimension to PLUTO which involves schools more directly. While PLUTO is in essence a network of teacher training institutions, a small number of schools will be associated with each institution, which will participate in the network at their own levels (Primary with Primary and Secondary with Secondary). Thus the fully-developed PLUTO will be a three-tier network, under the overall supervision of the teacher training institutions, and already a number of schools are very enthusiastically involved.

In each country however, the teacher education institution will be the central node, charged with giving support to the schools on the technical and the pedagogic sides. Additionally, the teacher training institutions will collaborate among themselves, on the basis of their experience with the schools, to produce teacher and pupil guides and other support materials. These materials will be produced in international versions, so as to extract maximum benefit from the PLUTO experience.

IV. IMPLEMENTING THE NETWORK

While we believe it essential to start from a definition of the educational targets, it is essential also that the concept be made to operate. This has involved us in decisions about hardware, about software and about communications.

We were clear from the outset that the Project needed to run on 'serious' microcomputers, that is on industry-standard machines and not cut-down 'educational' or 'home' computers. This was the thinking that led the proposing institution, Manchester Polytechnic, to place the PLUTO concept before IBM (Europe), where a sympathetic hearing was readily obtained, and start-up and implementation support agreed. The UK and Denmark IBM organisations also agreed to meet costs within these two countries. In Portugal and Sweden, however, other sources of support have been established, and the Project should by no means be seen as exclusively IBM-supported.

The same is true of hardware. In some cases, IBM equipment has been donated, but the products of other manufacturers are also in use - in Sweden, for example, tha favoured machine is the Apple Macintosh. It has been understood from the outset that PLUTO would need to accommodate a divesity of machine types.

This is all the more reason why software needs to be chosen with care. There is little problem with text, given that wordprocessed files can be transmitted in ASCII form. More care needs to be taken over database and spreadsheet operations, however. In the first place, programs used in collaborating institutions must be either the same or compatible; there is no point in one institution's producing files which cannot be read by the other institution's software (for example, a spreadsheet might contain too many cells; a database file produced on one package might presuppose more search criteria than could be accommodated on another - and so on). Careful attention is also being paid to the formats in which database and spreadsheet files may be exported.

(In this context, we note that some packages, such as Microsoft Excel are of particular interest in that they exist in both IBM PC and Macintosh versions, and we are currently exploring the potential of such compatibility.)

Given that the aim throughout is the eventual production of a system which will be as supportive as possible to the non-specialist user, two very important questions raised have been that of the network carrier to be used, and that of the communications software used to access that carrier.

The second of these is the easier to answer. The team at Manchester Polytechnic has experimented with a number of packages, including Breakout, Crosstalk XIV and Procomm. Each has its own merits, and at the time of writing the new version of Crosstalk, Crosstalk Mk 4, is under review. This is very promising indeed, since it has a powerful built-in script language (CASL) which allows for the automation of seemingly any communications process which could be required within PLUTO. (One argument against Crosstalk Mk 4 from a UK point of view is that it does not support the 1200/75 baud rate demanded by viewdata services such as PRESTEL. There are other packages which may well be suitable and which have not yet been examined. However, in practice so far we have kept coming back to a UK package, Dialup (in its Dialup Educational version), which we find reliable and user-friendly. Because it is menu-driven, it is not the speediest package for the experienced user, but it has the great merit of combining a reasonably comprehensive range of features with a user interface which is more supportive to the non-specialist than is that of Crosstalk Mk 4. For this reason, it may well be the package which we adopt for student and schools use, while perhaps selecting Crosstalk Mk 4 for use by the development team; a Dialup Professional version is promised for the near future, and this will be of considerable interest to PLUTO. (We should add that these remarks are made from the viewpoint of the Manchester team, and that colleagues in other PLUTO institutions may well have their own preferences.)

Another communications package which has to be a strong candidate is that supplied to users of The Times Network for Schools, which is widely used by educational institutions in the UK. While not menu-driven, the TTNS software also is relatively easy for the non-specialist to use. This possibility, however, takes us into the realm of decisions about compatibility between network carriers, which is a less straightforward issue altogether.

A first decision was to use EARN, and indeed this is the carrier being used at the time of writing, partly because EARN already exists as a cross-border carrier and partly because there was already a commitment to EARN on the part of Danish partners. EARN as such, of course, is not used in the UK but is accessed through the JANET network. In practice, the JANET - EARN route is acceptable and operable so far as the Project team at the Polytechnic is concerned, but with reservations. First, it is felt that the user interface to JANET is not sufficiently friendly for non-specialists. A second and more important problem concerns the participation of schools in JANET: at present, only Universities and Polytechnics can register as users of JANET, and this leaves an operational problem so far as the schools communication is concerned. The only way around this problem has been to have schools transmit their files to the Polytechnic and for the Polytechnic team to forward them via JANET - EARN. This is a wholly unsatisfactory solution for a number of reasons, and we are currently seeking acceptable ways around this problem.

The obvious UK solution, as mentioned already, is to use The Times Network for Schools, and this option is currently under review. It has the great advantage of offering a ready-made system oriented to educational use. Its disadvantage is that it involves institutions in other countries accessing TTNS via international calls, albeit at IPSS rates, and it is this that is the subject of careful discussion. There may also be a question mark against the existing file transfer protocols of TTNS.

Yet another alternative being studied is the PORTACOMM system, which offers all the facilities required by PLUTO, including access by all levels of institutions. PORTACOMM's bulletin board facility is also of interest; however, any decision to use this network also raises important issues of cost.

The Project team have no doubt that these issues will have been resolved, at least on an interim basis, by the time that this paper is given at the Edinburgh Conference, and the opportunity will be taken there to present the arguments which finally determined the outcome of the debate. What this issue has highlighted so far, however, is the importance, in any project such as this, of selecting a carrier which meets the criteria of:

- offering the necessary range of facilities,
- allowing of user-friendly access and use,
- being as inexpensive as may reasonably be expected.

Once the decision on the carrier has been taken then decisions on preferred communications software will be finalised. It is not in fact absolutely necessary to standardise in this area, though a commonality of software would make the task of writing teacher and pupil manuals much more straightforward.

In practice it has been found that the time spent so far on the mechanics of establishing the network have outweighed the time which it has been possible to devote to educational activity. Nonetheless, this is perhaps to be expected in the early stages of what is, after all, an ambitious and pioneering project.

V. FUTURE DEVELOPMENTS

There are interesting questions to be faced, in the mid-term, about the future development of the network. Reflection suggests that there are in fact two phenomena to be considered which are similar but distinct.

The first is the Project, i.e. the business of setting up the network and of establishing its working modalities. Project activities include the planning of activities, the preparation of materials and the monitoring of outcomes. Within the Project it is necessary to maintain a degree of coherence while allowing flexibility - in other words, there has to be a Project identity, a set of activities which are the first and immediate concern of PLUTO.

The second is the network itself, as it is likely to exist by, say, mid-1989. By this time it will be possible to open up the network in the original participating countries (for reasons which we explain below, it has to be a closed group at the outset). But at that stage we have to anticipate that there may be so many participating institutions that the cohesive activity will no longer be possible and certainly not desirable. In that case, the network will have created its own identity, its own self-sufficiency, and the nature of the Project will change. Project activity at this point will become more a matter of inducting new users, of negotiating extensions to the network which may be, at present, difficult for economic or political reasons, of monitoring and introducing new technologies and new software and of tackling the outcomes of Phase I if they are to meet the needs of Phase II. It is an interesting and challenging scenario, and the transition from first-phase Project to second-phase Project will be a fascinating excercise. As yet, however, the outlines of that transition are slightly too distant for any guesses to be of value.

What perhaps may be clear are the reasons why, at present, PLUTO has to be a closed group. There has to be a cohesive activity, a monitoring of progress, and the plain fact is that all of this has to be kept within manageable bounds. To open up PLUTO at this stage would be to make it unmanageable and, as a consequence, to put it at risk. That risk is not worth taking.

The guidelines for PLUTO are firmly in place, and first activities have commenced. It is - we are happy to say - difficult to predict the Project's final outcomes, and indeed the word 'final' is probably a misnomer in this context. More than one writer on education has suggested that school as we know it is modelled on the factory of the nineteenth century. Some have gone on to suggest that, as a matter of historical inevitability, that model will itself be superseded, and that what takes its place may be a form of school, or of access to learning, which takes the network, with its open form of communications, as its model. There are a number of developments in European education, among them the PACE Project and the EEC DELTA programme, which point already in the direction of the network model. We believe that PLUTO does likewise, and that it is a most interesting direction in which to travel. In five year's time, we shall have much to report.

ISBN 0 905941 28 4 Two Vols
0 905941 27 6 Vol 2

CEP
Consultants
Ltd

360